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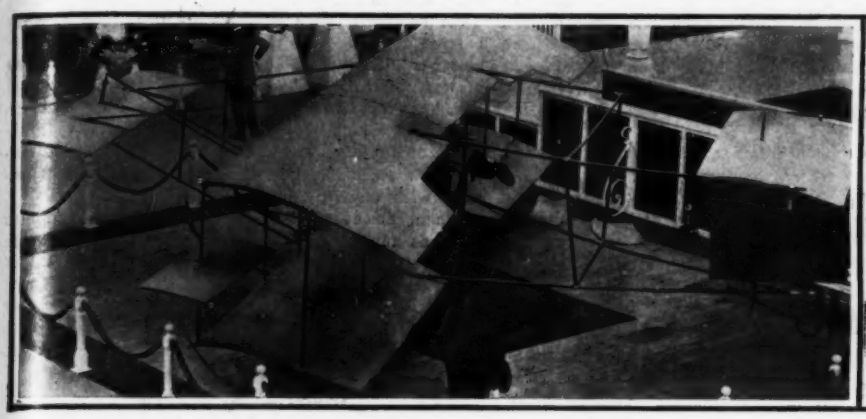
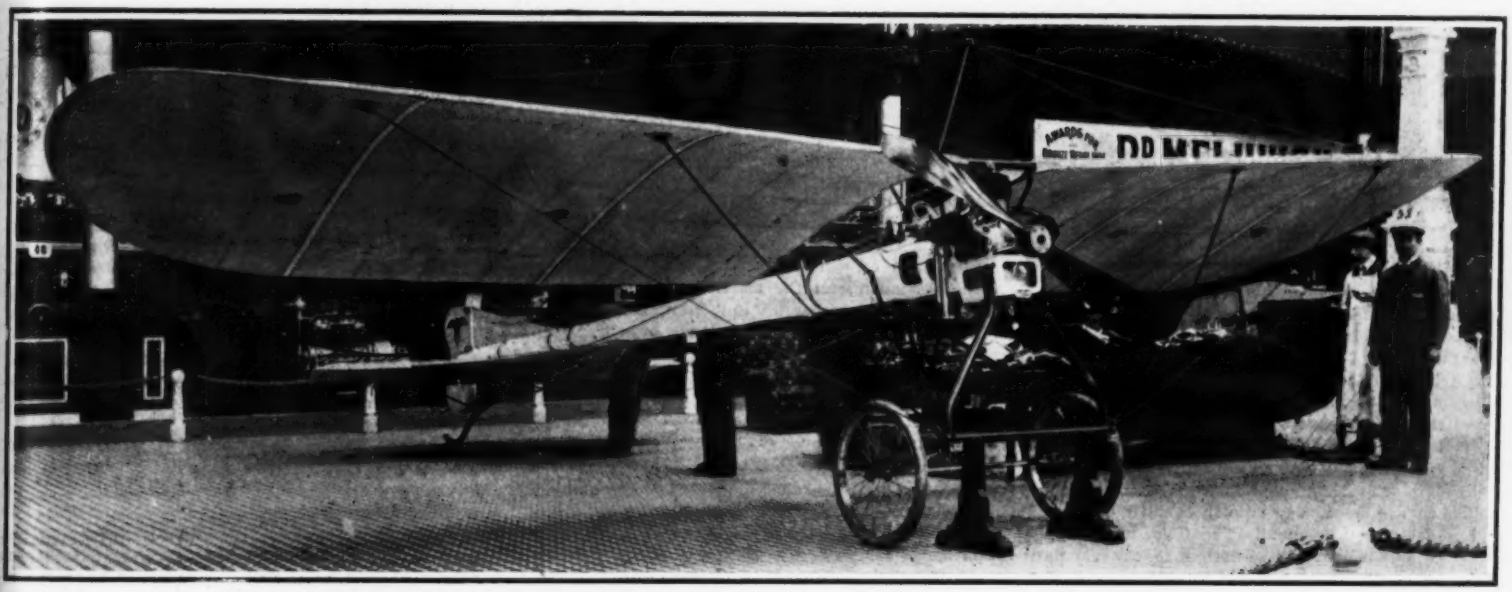


THE GEORGE AND JOBLING BIPLANE, WHICH RESEMBLES THE CURTISS IN SEVERAL RESPECTS.

MESSRS. SHORT BROS. MODIFIED WRIGHT MACHINE WITH FIXED CRUCIFORM TAIL WHICH WON THE £1,000 PRIZE FOR THE FIRST MILE FLIGHT BY AN ENGLISHMAN.



THE LE BLON-DELAGRANGE-HUMBER MONOPLANE WITH TUBULAR WOODEN BODY.

THE HOWARD WRIGHT BLÉRIOT TYPE MONOPLANE WITH LANDING CHASSIS.

THE OLYMPIA AERO EXHIBITION AT LONDON.—[SEE PAGE 231.]

THE ELECTRIC FURNACE.*

PROGRESS IN THE MANUFACTURE OF IRON AND STEEL.

BY P. M'N. BENNIE.

It is to be regretted that an account of progress in the application of the electric furnace to iron and steel production has to draw so many of its data from foreign sources and so little from work done in this country. American steel makers have not as yet taken hold of this new metallurgical tool with their accustomed alacrity. Concerning the bare half dozen installations here very little is given out as to the metallurgical results attained.

At the annual meeting of the American Electrochemical Society last May there was presented an interesting series of papers, abstracts of which appeared in the Iron Age at the time. These papers were intended to show the state of advancement at the date of the meeting, and revealed the fact that much work and serious investigation are being carried on by many active and intelligent workers in the electric furnace field.

PRODUCTION OF PIG IRON.

So far as concerns the production of pig iron by means of the electric furnace, the practical work thus far appears to be confined to two installations, one at the Domnarfvet Works in Sweden, where a furnace designed by Gronwall, Lindblad and Stalhane is used. This furnace is referred to in the Iron Age of August 19th, 1909, and is also described more fully in a pamphlet issued by the Department of Mines of the Canadian Government. The other installation of importance is located at Heroult, on the Pitt River, Shasta County, Cal., where the Noble Electric Steel Company has put down an elaborate plant for mining magnetic iron ore and limestone on the premises, together with a complete plant for making wood charcoal with recovery of by-products.

The California electric furnace is a type developed after a series of experiments by Prof. D. A. Lyon of Stanford University, metallurgist in charge. This furnace has already been illustrated and described in the technical journals. It may be interesting to note here, however, the latest news with reference to the California enterprise. Some difficulty was encountered with the carbon electrodes, of which there are six in the furnace. This problem seems to have been at least partially solved, as we are informed that after certain alterations and improvements indicated by previous trials had been made, the furnace was started on a campaign December 13th, and a tap of eight tons of electric furnace pig iron made December 14th. The information is given that the furnace has since been tapped regularly and that no difficulties have thus far arisen.

It may be interesting to note the quality of the pig iron produced at this plant. The following analyses are given, by which it will be noticed that a very pure product is being turned out, low in sulphur and phosphorus:

	1.	2.	3.	4.
Silicon	0.94	0.84	0.98	0.94
Sulphur	0.042	0.037	0.049	0.002
Phosphorus	0.027	0.022	0.03	0.02
Manganese	0.11	0.03	0.08	Trace
Combined carbon	1.20	....	4.56	3.25
Graphitic carbon	2.06	....		

It must not be considered, however, that the accomplishment of making pig iron by the use of an electric furnace contains any menace to existing methods of producing pig iron. Even a broad interpretation of the establishment of the new method can only mean that an apparatus has been devised suitable to certain conditions where the older methods would be found impracticable. The application of the electric furnace process will, therefore, find its growth and development in certain restricted localities where conditions favorable to it exist, without the slightest intention of invading those districts favorable to fuel fired furnaces.

It is worthy of remark that the analyses thus far published seem to indicate an iron of exceptional quality, so it may be that, owing to its peculiar conditions of production, electric furnace pig iron will create a special market for itself. Some of the product made by the Noble Electric Steel Company has already been used for castings by foundries at Redding, Cal., with extremely satisfactory results.

PRODUCTION OF STEEL.

During the past year much progress has been made with electric furnaces as applied to steel production, commercially and metallurgically. The application of such furnaces is practically confined to those types developed by such prominent and able workers as Stassano, Keller, Heroult, Girod, Kjellin-Colby and Rochling-Rodenhauser. Each of these types has already been described in more or less detail in these columns, so need not be reviewed here.

Of statistical interest, however, and as showing the rapidly widening application of the electric furnace as a metallurgical apparatus upon the commercial scale, it may be mentioned that of the prominent types the following furnaces have already been installed or are in course of construction:

Name.	Number.
Stassano	12
Keller	4
Heroult	20
Girod	18
Kjellin-Colby	12
Rochling-Rodenhauser	12

The largest of these furnaces in point of tonnage are those of the Heroult type, one of which has been running for some time at the South Chicago Works of the Illinois Steel Company, and the other, which is just starting up, at the Worcester Works of the American Steel and Wire Company. Each of these furnaces is designed to handle from 12 to 15 tons at a heat. When it is considered that one of these furnaces working well will handle about 12 heats daily, with a total daily production of 150 to 180 tons, it will be realized that so far as capacity goes the electric furnace has freed itself from the reproach that it is only a plaything. Girod has installed a complete steel works at Ugine, where he has two furnaces of 12 tons capacity each, thus running the Heroult type a close second.

The apparent apathy of American steel makers, located as they are in the greatest steel-producing country in the world, to a revolutionary innovation which has already gathered considerable momentum abroad is rather unaccountable. Our steel manufacturers have seldom been accused of ultra-conservatism, yet among all the electric steel furnaces now listed we make rather an indifferent showing. Still it is some satisfaction to know that, even if we have not so many installations to mark our progress, we do possess the largest electric steel furnaces so far in operation. Something like 25,000 tons of electric furnace steel was made in the United States in 1909, while the production for 1910 will reach at least 75,000 tons. The year 1909 marks the first appearance of the electric furnace product in our steel statistics in substantial quantity. A number of the installations now under way and projected may materially increase this figure for 1910.

PROGRESS IN FURNACE OPERATION.

Perhaps of greater interest is the technical progress with regard to furnace operation and metallurgical practice. In types of furnaces so widely apart as those of Stassano, Heroult and Rochling-Rodenhauser it might be expected that technical problems peculiar to each would be encountered, and such has proved to be the case. By reason of the somewhat higher temperature generally attained with electric furnaces, the matter of refractories becomes of prime importance, presenting a problem common to all electric steel furnaces. It is gratifying to record, therefore, that with reference to this problem, a careful choice of refractory materials, coupled with improved methods of application, has resulted in greatly prolonging their life, and consequently reducing the cost per ton for this important item. All electric furnaces are basic lined, and it has become almost the universal practice to use a proportion of tar or pitch as a component of the lining mixture; when this is baked in not too slowly good results are obtained. In this respect electric furnaces differ from other steel making furnaces.

Another problem peculiar to electric furnaces of the electrode type is the matter of electrodes, the difficulty being intensified in the larger furnaces where the electrodes attain hitherto unprecedented dimensions. The electrodes being made of carbon, and that material presenting unusual difficulties of manufacture with increase of size, it may be said that the chief difficulty with furnaces of the electrode type now rests with the electrodes. Here again it is interesting to record that much progress has been made, and that as careful investigation along approved scientific lines is being carried out in several quarters, we may expect to see substantial amelioration in quality and trustworthiness at an early date. When the electrode problem shall have been completely solved, a further important reduction in the cost of making steel in electric furnaces will have been accomplished.

The cost of electric power still remains of considerable moment where melting from the cold state is carried on. It should be borne in mind that heat energy electrically developed is not "cheap" energy, when compared with heat energy developed by combustion of fuel. This is especially true where electric power is steam generated, that being a roundabout way of using the calorific energy of fuel. Its advantage lies, however, in the tractability of electric power, the ease with which it may be controlled, the temperatures of the metallic bath regulated, the high temperature attainable and metallurgical conditions possible with electric furnaces.

When, however, it comes to treatment of molten steel, as an operation secondary to Bessemer or open hearth treatment, the electric energy is being used under extremely favorable conditions, for it is found with the larger furnaces that a power consumption of 100 to 150 kilowatt-hours per ton suffices. Where 50 to 75 tons per horse-power-year can be thus treated this item becomes of minor importance.

METALLURGICAL PROGRESS.

To those conversant with the facts the greatest significance attaches to the metallurgical progress being made. Electric steel furnaces present new metallurgical conditions to the steel maker, with the result that a new metallurgical practice is being developed.

Hypothesis and theory are following hard upon observed results with electric furnaces. These results are throwing light upon things that can occur under certain conditions, so practical steel makers would do well to pay close attention to these phenomena, as possibly indicating interesting experiments with existing apparatus, particularly the open-hearth furnace.

One thing has been conceded to the electric steel furnace, which is that with reference to elimination of oxides, sulphur and phosphorus it has shown ability to rapidly remove these deleterious impurities to an almost unprecedented degree. Certain it is that, no matter why, the electric furnace is an efficient remover of certain things considered as undesirable in steel. This is one striking characteristic of the new metallurgy—improvement in quality by removal of things rather than merely rendering them supposedly innocuous by metallurgical nostrums.

An interesting paper on "The Electric Refining of Steel," by F. W. Harbord, is given in the Iron Age of August 19th, 1909, which sheds much light on the reactions said to occur in electric furnaces, resulting in the high degree of elimination of impurities, such as oxides, sulphur and phosphorus. Doubt has been expressed as to the possibility of hydrogen remaining in steel during the cooling period. The results of the tests at Sheffield, where heated ingots were subjected to reduced pressure, emanating gases pumped off and analyzed, should settle that point. Moreover, the doubting ones neglect the possibility of hydrogen existing in the combined state as iron hydride. It is a fact, however, that nothing is specifically done in electric furnace treatment toward the removal of one other element which has recently been blacklisted by metallurgists. We mean nitrogen. As titanium seems to combine readily with this element, the resulting compound readily entering supernatant slags, the small addition of its ferroalloy would probably be justified by results.

Aside from data published by those interested in the various types of furnaces very little has been made public as to the physical results obtained, particularly with regard to steel charged molten into the electric furnace for final refining and finishing. We have no doubt whatever that the trained metallurgists in charge of these installations are finding out things of material benefit under these new conditions of operation. From an authentic source, however, we learn that steel rails have been made from some heats to see what physical characteristics they possess, with results that were surprising, the rails showing extreme toughness, resistance to shock and high quality superior to ordinary rails. Dr. Heroult assures us that for similar analyses the electric furnace product shows approximately 20 per cent. higher tensile strength and elongation than the product of ordinary methods.

One line of manufacture in which the advantages of electric furnaces and their product seem suddenly to have been realized by steel makers is in steel castings. Several of the plants in Europe have been in-

* Iron Age.

stalled for this particular purpose. Making steel castings by the open hearth method is at best an expensive, troublesome and uncertain process. It is claimed for the electric furnace, and with good reason, that aside from the improved quality obtained there is a large saving in defective castings, these items outbalancing the enhanced cost to such an extent that profits are actually increased. Several important installations for this purpose in the United States have been decided upon. We are informed from a trustworthy source that the establishment of a plant of electric furnaces, will shortly be announced.

An interesting innovation has been made at a works in Europe, in the Luxembourg District, where hot Luxembourg metal is charged into a four-ton electric furnace with 25 per cent. scrap, the entire operation of removing carbon, sulphur and phosphorus being conducted in the one furnace. The hot metal contains 1.8 per cent. phosphorus and 0.20 per cent. sulphur, the final product being soft steel for castings, containing 0.1 per cent. and below of carbon, with sulphur and phosphorus below 0.02 per cent. This looks like duplexing with a vengeance, using the blast furnace and the electric as the units. This works reports that there is no lack of orders at a profit.

Finally, an important feature of electric steel furnace progress is the relief held out to existing Bessemer plants which have been facing the necessity of some sort of duplex process or going over bodily to the open hearth. We believe the electric furnace is going to fulfill its largest function as one unit in a duplex process, and that the Bessemer plus the electric furnace will be found a better combination than Bessemer plus open hearth; also that the open hearth plus electric will be a better combination than two open hearths.

FAST AND FUGITIVE DYES.

SOMETHING ABOUT THEIR CHEMISTRY.

BY PROF. OTTO N. WITT.

I HAVE repeatedly called attention to the confusion of ideas which prevails in regard to dyestuffs and the colors which they impart to textile fabrics. An old proverb says that many men talk of many things as a blind man talks of colors. Color is one of the things which men most often speak of as if they were blind. The most absurd statements concerning the difference between fast and fugitive dyes are made by persons who do not know what they mean by the terms "fast" and "fugitive." The commonest and most popular conclusion is that all "natural" dyes are fast and all "artificial" dyes are necessarily fugitive. I have often endeavored to destroy this myth of natural and artificial dyes, by showing that there is no real difference between these two classes of dyestuffs, and that all dyes are members of the same great family of chemical compounds and all are subject to the same laws. It is only a question of time and chance whether a particular dye appears in the market as a natural vegetable or animal substance or as a product of human skill and industry. This truth is illustrated by the two celebrated examples of alizarin and indigo, both of which are now manufactured and artificial products, after having played the most prominent parts as natural dyes, during thousands of years. But argument and demonstration are wasted on a great many persons, who pin their faith on the old fable and even boldly assert that alizarin and indigo, the classical examples of fast dyes, have lost their virtues since they have appeared in the market as artificial products. For not even alizarin or indigo is as unchangeable and "dyed in the wool" as prejudice.

The "fastness" or permanence of a dye is not a single uniform quality, but comprises numerous varieties, and there are very few dyes which possess every variety. Permanence is simply the power to resist destructive influences, and dyed fabrics are subjected, in the course of time, to so many different influences that the fastest of dyes may occasionally be injured. A drop of nitric acid, for example, falling on a garment dyed with indigo, will instantly produce a yellow spot, which cannot be restored to its original color, no matter whether the indigo used in dyeing the cloth is of natural or artificial origin. But most dyed fabrics are exposed very freely to sunlight, which is a more powerful agent than nitric acid. Hence the power to resist the action of light is the most important of all varieties of permanence, and we will devote especial attention to it.

The number of dyes that can be exposed without injury to long continued direct sunlight is exceedingly limited. On the other hand, there are many dyes which may be regarded as fast in daylight, and which may safely be exposed to daylight, and even to sunlight, as freely as the weavers of the dyed fabrics are accustomed to expose their own persons. The most permanent of dyes is somewhat affected by bright and continuous illumination during months and years, but a dye that fades in a few days or hours of exposure is properly classed as fugitive.

We see, therefore, that there is no difference in kind, but only a difference in degree, between fast and fugitive dyes. Both are affected by light, but in one case the effect produced is so small that it may be disregarded, while in the other it is sufficiently great to constitute an injury. The extent to which a dye is altered by a given exposure to light depends upon the structure of the molecule of the dyestuff. Increase of knowledge of the chemical constitution of dyes will bring a clearer understanding of the laws which govern the resistance of dyes to the action of light, and even now we are able to draw some correct theoretical conclusions in this difficult field of chemistry.

In order to draw such conclusions, however, we must endeavor to obtain an insight into the nature of the action which light exerts upon colored substances. Here, unfortunately, the views which prevail, even among men who have made a special study of dyes, are so confused that it may be of service to suggest that every orderly investigation of natural phenomena should commence by clearly indicating the object of investigation.

We know that light destroys a dye, according to its character, rapidly, slowly or (practically) not at all. We desire to know just what light does to fugitive dyes and what fast dyes do to light. When a walnut is struck with a wooden mallet the nut is broken, but when an iron anvil is struck with the same mallet, the mallet is broken. We continue to see all the objects and therefore we understand what has taken place, but if the nut simply vanished in the first experiment and the mallet vanished in the second, the phenomena would appear very mysterious.

Light corresponds to the mallet impelled by muscular force. It is a form of energy, which is applied to the molecules of the dyestuff. The walnut and the anvil represent the fugitive and the fast color, the passive objects, of which the former is destroyed by the applied energy, which the latter successfully resists. We wish to know how each of these results is brought about.

To this question the existing literature of the subject (with the exception of certain articles of mine) gives a very inadequate reply. Some writers assert that light oxidizes, others that it reduces, dyestuffs. It is evident, however, that no form of energy can produce exactly the same effect upon all dyes, because no two members of this great family of chemical compounds agree precisely in molecular structure. Sunlight, furthermore, is not a single form of energy, but includes vibrations of very different wave lengths, which can be traced into the ultrared and ultraviolet regions, far beyond the limits of the visible spectrum. The effects produced by the ultrared rays are chiefly thermal, but the chemical power of the rays increases steadily from the red to the violet end of the spectrum, while in the ultraviolet region we find rays that can be detected only by their chemical effects. The power of ether vibrations to cause chemical transformations is easily comprehended when we remember that the atoms of a chemical molecule are also in vibration. By the influx of additional energy this intramolecular vibration is increased often so greatly that the molecular combination is destroyed. In all chemical compounds, the absorption of energy from without necessarily increases the tendency to dissociation.

The colors of all bodies are produced by selective absorption of the light that falls upon them. A dyestuff, like any other colored substance, absorbs some of the rays of which white light is composed, and reflects or transmits the remainder. But this remainder is not white light. The eye detects the absence of the wave lengths that the dye has absorbed, and the sensation of color results.

Dyes and other colored substances can be studied and distinguished with the utmost precision by means of their absorption spectra. A glance through the spectroscope shows exactly which wave lengths are absorbed by the dyestuff. And when we find that no two dyes show the same absorption spectrum, we understand that no two dyes are really alike, no matter how closely they resemble each other, when regarded superficially. The results of this great diversity of interaction between light and dyestuffs cannot be summed up in a single word, oxidation or reduction. The majestic simplicity of nature is not quite as simple as that.

The error is caused by ignoring the essential part of the phenomenon. The sensation of color is produced by those rays that are not absorbed by the dyestuff, but the dye is destroyed by the rays that are absorbed. This absorbed light is energy which cannot be destroyed, but must reappear in one form or another. What becomes of it?—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

HUMAN NATURE AND CLOTHES.

"CLOTHES: A Human Nature Study," was the subject of a lecture delivered before the Selborne Society in the Burlington Gardens Theater by Mr. Wilfred Mark Webb, the honorable general secretary. Mr. Christy, who presided in the absence of Lord Avebury, said the subject was one which Mr. Mark Webb had made his own. We were all interested in clothes, for few things touched us more closely.

Mr. Webb said he proposed to show by lantern-slides what interest there could be got out of clothes when investigated as a nature study. The earliest garment was probably the shawl, which was also used as a petticoat. Make rows of stitches up the middle of the petticoat, give one long cut between them, and you got a pair of trousers. The hat-band on a man's hat was an interesting survival of the fillet with which the shawl was bound on the head. The Scotch cap, the Bishop's miter, and the little boy's sailor hat, with their tails and the bonnet strings could be referred to the same origin. The little bow in the hat-lining, at the end of the lacing, had its origin in the time when there were no one-eighth sizes, and head coverings could be laced in or let out according to the size of the wearer's head. Men when in uniform to this day wore their feathers on the left side, because when plumes were first used and men drew their swords more frequently they did not want in flourishing them to get them mixed up with their feathers. The cocked hat probably had its beginning in the age when hats were made so large that people took to looping them up temporarily, and afterward the habit became permanent. The helmet of the modern fireman had hardly altered since the ancient helmet of the Greek. The cockade had been traced back to the old hood, which, as it grew longer, was tied over the head, and the fringed end drooped over like a cock's comb.

The ordinary coachman of to-day was the gentleman of the middle of last century, the flunkey wore the knee-breeches of the George III period, and the page-boy's three rows of buttons came from the early reign of Queen Victoria. The groom's belt was for his mistress to hold on by when she rode pillion. The judge's wig with a hole in the top was not for ventilation, but referred to the time when judges were sergeants-at-law, who were members of the Order of the Coif.

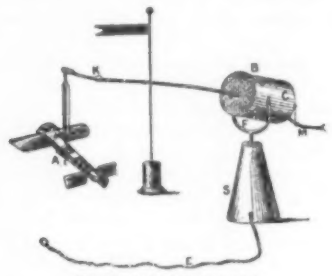
In a French patent recently issued to O. Serpek a process is described of manufacturing pure alumina. In this process pure alumina is obtained by heating bauxite or other raw material to a temperature at which impurities are volatilized, a current of air or other gas being maintained to completely carry away the volatile products. Or, carbon may be added and the heating effected in the presence of nitrogen or a gas rich in nitrogen, which, at a temperature above 1,600 deg. C., causes impurities to volatilize and gives aluminium nitride, the latter being transformed into pure alumina, with the liberation of ammonia as a valuable by-product, by treatment with water under pressure. If iron be present, it may be removed from the nitride by means of dilute acids or chlorine, or in other manner. Even clays may be economically treated by the process and give a product pure enough for use in the preparation of aluminium.

NOVELTIES IN TOYS.*

SOME INTERESTING FRENCH INVENTIONS.

THE VIROPLANE.

THE viroplane is a new and ingenious toy, the operation of which is based upon the gyroscopic phenomenon known as precession. When a solid of revolution, which is rotating rapidly on its axis, is subjected to the action of a couple of external forces, it assumes a second rotary movement, called a movement of precession, about an axis parallel to the direction of those forces. Thus, the axis of a spinning top, under the influence of the couple consisting of its weight, acting downward at the center of gravity, and the reaction of the floor, acting upward at the apex of the peg, describes a cone whose axis is the vertical line which passes through the fixed point, i. e., the apex of the peg. In the viroplane, a flywheel *V* is inclosed in a tin cylinder *B*. The common axis of the flywheel and the cylinder is prolonged, outside the cylinder, by a steel rod *T*, about 20 inches long, from the end of which is suspended a little aeroplane *A*. The whole is supported by horizontal bearings *C*, at a point between the flywheel and the center of gravity of the whole system, so that the aeroplane rests on the floor when the flywheel is not rotating. The bearings *C* are attached to



THE VIROPLANE.

the prongs of a fork *F*, which can be caused to rotate about its vertical axis *D* by a friction device *R*, which is operated by twisting a button at the free end of the spiral spring *E*. The flywheel is caused to rotate by turning the crank *M*, the movement of which is transmitted to the flywheel by the multiplying train of gearing *G*.

The aeroplane, suspended from the other end of the rod, is affected by two movements of precession of the flywheel, which are produced, respectively, by the constant vertical couple due to the weight, and by a variable horizontal couple due to the rotation of the fork at the will of the operator. Each of these couples produces, at any given instant, a perfectly definite movement of precession. Thus, by twisting the button from left to right, the aeroplane is caused to rise from the floor, while it sinks when the button is turned in the opposite direction. If the button is not touched, and the force of gravity is allowed to act alone, the aeroplane soars in a circle at a nearly constant height. The couple due to the weight and, consequently, the mean velocity of the aeroplane in this movement of precession can be regulated by moving a sliding weight *K* on the rod *T*. The aeroplane is suspended from

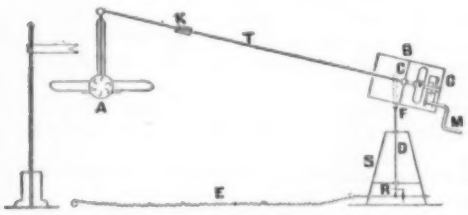
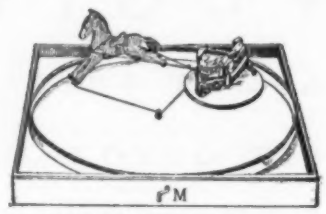


DIAGRAM OF VIROPLANE.

one of its highest points and is, therefore, in stable equilibrium. As its center of gravity is considerably lower than the point of suspension, it is subjected, when both couples are in operation, to additional couples, due to inertia, which cause its bow to tip upward when it is rising and downward when it is descending, in the manner of a real aeroplane. In order to make the viroplane a game of skill as well as an interesting scientific toy, several little flags are placed along the path of the aeroplane, to serve as marks to be hit or obstacles to be avoided. The jury of the Lépine exhibition of toys has very properly awarded a grand prize to this ingenious and interesting invention.

A MECHANICAL CIRCUS.

In a new French mechanical toy the performances of the circus are imitated by means of very simple apparatus. The floor of the circus is the false bottom of a shallow square box. Beneath this false bottom is a pinion, which is turned by a crank (*M*) at the side of the box, and drives a large horizontal toothed wheel, the axis of which protrudes through the floor of the circus at its center. Two radial wires, attached to this axis, serve as supports for the feet of a horse or a human figure. In the illustration the horse appears to draw a disk on which two clowns are seated, and which

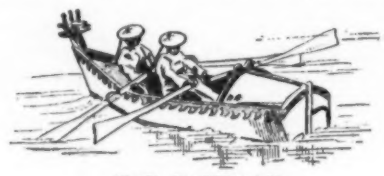


MECHANICAL CIRCUS.

presses against the rim of the circus and consequently revolves on its own axis as it is drawn round the ring. A clown and a wheelbarrow may be substituted for the horse and disk.

A TOY ROWBOAT THAT IS REALLY ROWED.

The jury of the Lépine exhibition has awarded a grand prize to an ingenious toy rowboat, provided with jointed figures of rowers, which ply their oars in the orthodox manner, and thus propel the boat through the water. The mechanism by which these movements are effected is indicated in the accompanying diagram. The prime mover is a coiled spring, the barrel of which carries a pin, *M*, which, by means of a driving rod, moves a series of jointed parallelograms, *ADOC*,



TOY ROWBOAT.

etc., equal in number to the rowers. The bases of the parallelograms are connected with the rod of a piston moving in a horizontal cylinder *H*, which has an orifice, the size of which can be varied by moving the lever *L*. The cylinder thus acts as a brake, or escapement, and allows the speed of the rowers to be regulated by means of the lever. The oarsman's body is pivoted at *C* and his oar at *B*. By the connection of the levers *OC* and *OB*, and the combination of the movements of transition and oscillation, the blade of the oar is compelled to move in an oval curve, dipping into

DIAGRAM AND MECHANISM OF TOY ROWBOAT.

the water when moving backward, and emerging when moving forward.

A PRACTICABLE TOY STEAMBOAT.

Desvaux, of Paris, has constructed a practicable toy steamboat which is driven by a very well constructed engine and can attain a speed of ten miles per hour. The hull of polished mahogany is 50 inches long, has a maximum width of about 7 inches, and weighs about 4 pounds. The weight of the boat complete, with its machinery, is between 11 and 12 pounds. A peculiarity in the construction of the hull is the presence of a diminutive keel, which is deepest at the bow and dwindles to nothing at the stern. This construction diminishes the draft, at full speed, without entirely sacrificing stability, and in connection with the concave form of the forward part of the vessel, it allows the engine to be placed low enough to make the shaft nearly horizontal.

The machinery is sufficiently interesting to deserve

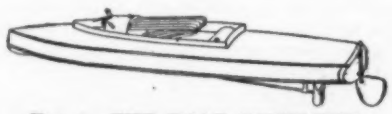


FIG. 1.—THE BOAT COMPLETE.

detailed description. Its total weight is only 5¼ pounds, and the engine, which makes 1,400 revolutions per minute and develops 1/12 horse-power, weighs only a trifle more than one pound. The engine (Fig. 3) occupies a space of 5 x 3 x 1¼ inches. It has four cylinders, which are arranged in groups of two, in respect to the admission of steam by means of the slide valve. The cranks of the two cylinders of each group are opposite each other and at right angles to the cranks of the other two cylinders. Hence the engine has no dead point, so that the flywheel can be omitted and weight saved. The cylinders are single acting, the steam exerting pressure only on the anterior or upper

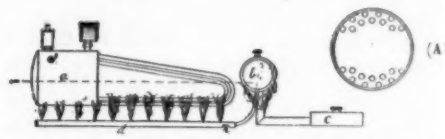


FIG. 2.—THE BOILER (LONGITUDINAL AND TRANSVERSE SECTIONS).

faces of the pistons. In the position of the pistons shown in Fig. 3, the pistons of the cylinders of group *A* are at the middle of their course. The piston *b* is being forced downward by the pressure of the steam and its crank being horizontal is exerting its maximum torque on the shaft, while the piston *a*, pushed upward by its crank, is expelling the exhaust steam from its cylinder into the atmosphere. At the same instant, the pistons of group *B* are at the ends of their course, *d* beginning to act on the shaft and *c* beginning to expel exhaust steam. Hence only two pistons, one of each group, act on the shaft at any given instant, and while one of these is at the beginning or end of its course and exerting its minimum torque, the other is at the middle of its course and is producing its maximum effect.

The boiler (Fig. 2) consists of a reservoir, *a*, and eleven tubes which extend horizontally from the lower part of the reservoir to a certain distance and then bend and return to the reservoir, near its top. The reservoir is a horizontal cylinder 3½ inches in diameter. It is provided with valves, blow-off cocks, a steam gage and the other customary accessories of steam boilers. The normal water level is indicated by the dotted line. The upper branches of the tubes are filled with steam.

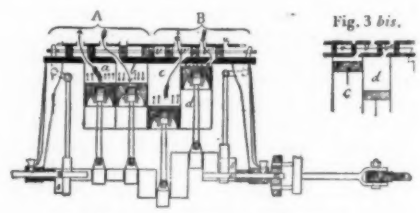


FIG. 3.—THE ENGINE.

The fuel employed is alcohol, in the form of vapor. The alcohol is contained in a vessel *b*, which is heated by an ordinary spirit lamp *c*, and the alcohol vapor passes into four tubes, *d*, placed horizontally beneath water tubes and the cylindrical boiler, drawing with it a certain proportion of air, which enters through the orifice *r*. The mixture of air and alcohol vapor escapes through orifices at the top of the tubes *d* in a number of fine jets which, when ignited, heat the boiler so rapidly that the maximum pressure, 71 pounds, is developed in two or three minutes. The flame is then moderated and the speed of the engine is diminished, in order to prevent condensation.

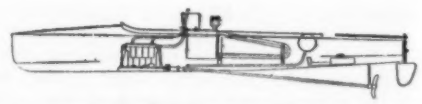


FIG. 4.—ARRANGEMENT OF THE MACHINERY.

The organs of control are grouped at the stern of the boat for convenience of operation and to enable a course to be laid correctly for a given point. There is a rod connected with the throttle valve and a lever by which an escape valve can be opened when the pressure becomes too high. (There is also an automatic safety valve, controlled by a spring, and set to 85 pounds.) The boat is steered by a rudder of sheet copper, which is placed at the left side of the stern in order to escape the influence of the eddies formed by the propeller. The vessel holds its course very well to a distance of a hundred yards.

This ingenious toy steamboat is very interesting in every way, but it is, necessarily, much more costly than a sailboat of the same size.

* La Nature.

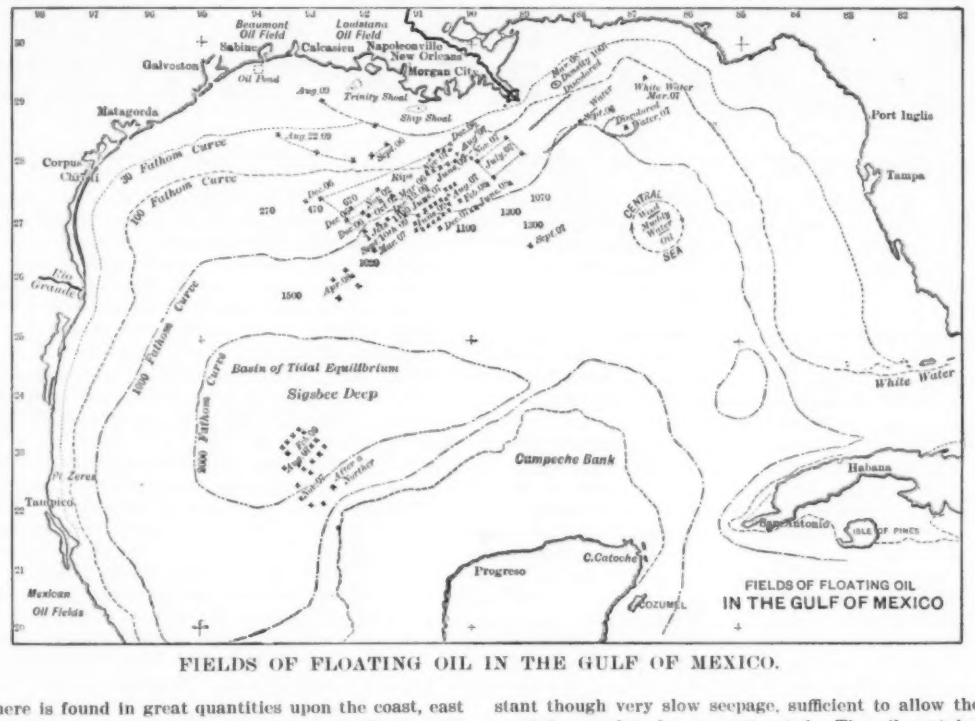
THE OIL FIELDS OF THE GULF OF MEXICO.

THEIR GEOLOGICAL PLACE.

BY LIEUT. JOHN C. SOLEY, U. S. N.

LOCATION.—The accompanying chart shows the position and extent of the oil field as located by the reports received during the last five years. The area within which floating oil has been found extends from latitude 26 deg. N. to 28 deg. 30 min. N., and from longitude 89 deg. W. to 93 deg. W. As the location extends in the direction of the flow of the main current of the Gulf Stream, it is probable that the area shown is much larger than the actual area from which the oil escapes. The most active part of the field is about 120 miles south of Trinity Shoal off the Louisiana coast.

History.—The appearance of bitumens in various shapes in the Gulf of Mexico dates back to the earliest history of this country. They have been reported by navigators at different times, at different points and in different forms, but the fields of floating oil have attracted little attention though it is believed that they have always existed. In 1543 the companions of DeSoto, after his death, sailed down the Mississippi and along the coast to the westward and found numerous evidences of the presence of the bitumens. Taking refuge from a storm in a creek, they found a scum cast up by the sea like pitch, with which they payed the bottoms of their vessels. In 1598, a writer says,



FIELDS OF FLOATING OIL IN THE GULF OF MEXICO.

"there is found in great quantities upon the coast, east and west of the Meschacebe, especially after high south winds, a sort of stone pitch called by the Spaniards copec; they mix it with grease to make it more liquid and use it as pitch for their vessels." Acosta, the famous author of a history of the West Indies, affirms it to be generated of an oil which empties itself into the ocean in great quantities. The English sent to discover the Meschacebe found it in two places; the sea was covered with the oil or slime which had a strong smell. Another writer says that ambergris or gray amber was found on the coast from Cape Florida to Mexico, said to be a bitumen of naphtha which comes from certain springs or fountains that empty themselves into the sea and is coagulated by the salt water as succinum, commonly called amber. The floating oil has been noticed from time to time and has been reported in the newspapers occasionally, but in later years records have been kept carefully so that it is possible to locate the origin of the field and to determine its extent.

The Deposits.—The mud lumps which appear only outside the passes of the Mississippi in the borders of the Delta are upheavals resulting from gases caused by the decomposition of masses of vegetable matter which have floated down the river and been buried in the silt. The combination of these sediments of vegetable matter, the salt water, the exclusion of the air, and the impervious cover of the silt, offer ideal conditions for the production of bitumens; this is generally a long process, but the earliest stage of the process is found in these mud lumps in full force. The formation of hydrocarbons is promoted by the action of the sodium chlorid on the decaying vegetable matter and is helped by the presence of the fishes, diatoms, algæ, and other minute organisms of the ooze, which all furnish material for the change. A destructive distillation is set up by which the substances, heated without access of free oxygen, undergo complex decomposition by which volatile products escape and a residue of carbon is left. Under the very moderate temperature, the principal product of the mud lumps is methane or marsh gas. The pressure of the gas, and perhaps the weight of the jetties, finally forces upward the overlying mud in a dome shape which has been known to cover as much as 30 acres. Where they rise above the water, the lumps generally show a small crater from which the semi-liquid mud is extruded. By driving a pipe down through the lump, a gas escapes which is easily lighted.

Near the shore at Sabine Pass, west of the west jetty, there is a deposit of a viscid tarry liquid of bituminous odor, which impregnates the mud and, when the mud is stirred by wave action or mechanically, the globules of oil rise to the surface and spread out so that, in storms, there is no break, and the location has become celebrated as an oil pond. The appearance is irregular and the origin is uncertain; the oil probably occurs in a porous bed under the water, whose cover is sufficiently pervious to permit a constant though very slow seepage, sufficient to allow the overlying mud to become saturated. The oil contains carbon, hydrogen, nitrogen and a trace of sulfur.

A peculiar substance called sea wax is frequently found on the beaches between Sabine Pass and Matagorda. This is found in large cakes as large as 6 or 8 feet long and 1 or 2 inches thick. It is undoubtedly a petroleum or asphaltum residuum and its presence points to the existence of springs of liquid bitumen somewhere in the Gulf.

The chart shows a number of oil spots south of Trinity Shoal from Ship Shoal to Sabine Bank, but these have only been reported in later years and are undoubtedly the refuse from the oil ships and barges when they clean tanks before going into Sabine Pass.

Along the Mexican coast and near Campeche Bank, floating oil is reported occasionally, but the first record appears in 1907, and it may come from either of two sources; from the northern field drifting before a gale or the overflow from the Mexican oil fields.

During the last seven years, the reports from vessels that have passed through the oil field in the Gulf have been frequent, principally because attention has been especially directed to it; the positions where it has been reported are plotted on the chart, so that its limits have been determined with considerable accuracy, and the point of origin has been located almost exactly as being at latitude 27 deg. 30 min. N. and longitude 91 deg. 30 min. W. A number of vessels have reported from this position that the oil was seen bubbling on the surface, while the report on September 10th, from the steamship "Comedian," described it particularly as coming up in three jets. It is generally described as dark or dark yellow, sometimes so thick that a vessel passing through will hardly make a ripple on the water. The oil floats away from the source in large fields, but it absorbs oxygen from the air and evaporates quickly. On evaporating the oily residue of hydrocarbons disappears and the emulsion, mixing with the water, first has the appearance of slime which is generally reported as discolored water, and later it turns the water milky white, which appearance is often reported in the eastern part of the Gulf current and as far south as the Florida Reefs.

The Source.—The location at 27 deg. 30 min. N. 91 deg. 30 min. W. is nearly south of the Trinity Shoal from which it is distant about 120 miles, and the chart shows depths of 600 fathoms. The Continental Shelf, with a general southeastward dip, is 90 miles in width from the Coastal Plain to the edge of the Shelf, at a depth of 100 fathoms (600 feet); in 25 miles from the edge, the bottom drops off to 600 fathoms (3,600 feet), and in 20 miles more to 1,000 fathoms (6,000 feet). The source may be at any one of these depths between 100 fathoms and 1,000 fathoms. Careful soundings would probably show, in this vicinity, the presence of one of the dome-shaped uplifts which are a peculiar topographical feature of the Coastal Plain of this region. The outlet of this ascending column of oil is probably located at some point of structural weakness or fissure from which the oil impregnated with sulfur floats upward, sometimes slowly and sometimes impelled by a tremendous force.

Movements of the Earth's Surface.—The crust of the earth, seemingly solid, slowly rises and falls, now revealing the bottom of a shallow ocean border as a land surface and again submerging a low continental border beneath the sea. Such movements have repeatedly taken place and they are still in slow progress; especially during the Tertiary Age the boundaries of the land and sea appear to have been in a state of frequent oscillation, judging from the proofs which the strata afford of the return of the ocean more than once to the spots from which it has retired. The deposits of ooze belonging to different periods or depths found on high land indicate that the movements of upheaval and subsidence have been going on continually, though the movement is slow. These changes are ordinary and not extraordinary events; movements of elevation are as common as movements of depression, but upheaval has been more rapid than erosion and more general than subsidence over the Coastal Plain and the Continental Shelf.

There appear to have been frequent oscillations throughout this territory, the land first sinking to the east and rising to the west; then the land in eastern Texas and southwestern Louisiana began to sink and continued to do so until a depth of 500 feet was reached at the close of the Eocene. After this, there was a gradual elevation increasing steadily, until the present shore line of Texas areas had an elevation of 400 feet. Following this high continental condition there was another depression when the sea again encroached on the land, the present shore line sinking to a depth of 100 feet below sea level. This sinking appears to have been accompanied by a tilting of the land and it was probably during this period that a considerable part of the flexing or faulting of the beds took place, resulting in the line of dome-shaped elevations, which occur in the southern part of Louisiana. Again the sea receded, and high level conditions prevailed, but the flexing or faulting of the preceding periods continued through this one, the domes were raised higher and their crests formed reefs and islands. The land subsequently tilted seaward, and enormous vegetable deposits were brought down by the floods. A further slight rise took place and the shore line moved southward about where the Trinity Shoal is now. The final change followed this elevation and present conditions were inaugurated, the sea began to encroach slowly on the land east of Trinity Shoal though to the westward the land is slowly rising.

These changes, which have been going on for centuries, have resulted in the formation of lines of structural weakness in the underlying formations though many of the fissures have probably been sealed by the deposition of overlying strata of sand and clay.

In the early formations the sands appear to be the heaviest deposits on the shelf, and the well records show the same conditions down to 500 feet with deposits of sandstones and limestones to a depth of 1,000 feet.

The porous beds underlying the Coastal Plain are thoroughly saturated, and in many places oil pools have formed. The location of the oil pools is dete

mined by certain structural features and particularly by the domes, while dislocations of the strata in the form of faults or flexures suggest the points where deposits of oil will occur. All the flexures on the land follow the northeast-southwest lines, and the axes of the dome-shaped uplifts on the land fall naturally into the same linear arrangement, while the slope of the great submarine flexure between 100 fathoms and 1,000 fathoms extending from Tampico to Mobile follows the same general direction and nearly coincides with the line of weakness on the Coastal Plain of the Atlantic.

Genesis.—It hardly comes within the scope of this paper to discuss the genesis of the petroleum, but the differences in the deposits at different points are so striking that they call for some notice, while the study of any subject which is based largely on hypothetical reasoning, is always enriched by suggestions which may or may not lead in a useful direction.

In the borders of the Gulf are the great oil fields of Mexico, Texas, and Louisiana, the salt and sulfur deposits of Louisiana, the coal and iron deposits of Alabama, and the phosphate beds of Florida. On the shores of the Gulf are deposited surface oils in different forms, and in the deep water there is a source of petroleum. There is a constant progression of an enormous body of warm water from the tropics which makes the circuit of the basin, following the contour of the Continental Shelf, and carries on its surface great floating fields of algæ. There is a great deep of 2,500 fathoms in the middle of the Gulf in which the water is colder and denser than elsewhere. The Mexican volcanoes extend over a fissure across the Mexican Plateau from Colima to Tampico, and the main line of structural weakness continues across the Gulf toward the Louisiana coast and extends northward through the igneous rocks of the Appalachian range to the basic lavas of the Palisades, and thence along the coast to Iceland.

The oils which are found on the borders of the Gulf and those which appear floating on the deep sea are so different in their characteristics that they seem to have been separated by nature into two classes, one having an organic and the other an inorganic origin.

The bituminous deposits along the shores, the methane of the mud lumps, the sea wax, the oil ponds, are probably all due to organic agencies. The vegetable and animal remains which have given rise to local deposits, the presence of the fucoids and diatoms in enormous quantities, which slowly decompose and sink into the oozes, the climatic conditions, and the temperature of the water, all contribute material for the change into hydrocarbons. But the oils in these deposits contain no soluble salts and no free sulfur. In some cases plants predominate in the formations, in others animal remains, and the resulting products vary as petroleum varies in different fields.

The floating oil in the deep water is probably of azoic origin. As it reaches the surface and absorbs the oxygen it evaporates quickly, and, when seen, it appears to be an alteration product which has many of the characteristics of petroleum spirit, containing sulfur compounds. It loses its fluorescence rapidly and degenerates into slime and then to milky water. Near the source, however, it is heavy, dark yellow and with a strong petroleum odor.

As the flow of oil at or near the same spot has been more or less continuous ever since the days of which we have any record, it is probable that there is an enormous oil pool underneath the Coastal Plain and the Continental Shelf of Louisiana and Texas, which lies at a depth of more than 2,000 feet. At the time of the last subsidence of the crust the impervious cover of the pool was probably borne down by the great weight of the superposed deposits until the cap rock was broken, allowing the continuous escape of some oil which had accumulated below that stratum. Under any circumstances it would be easy and natural for the oil to pass up through the water to the surface and be dissipated, but when we find the oil rising through a great depth of water with such violence as to displace the water in jets, it is evident that the pressure of gas behind the porous rocks is enormous.

The oil deposits of Louisiana which are known to be under the Coastal Plain, and those which are apparently under the extension of the Coastal Plain into the Continental Shelf, either immediately preceded or immediately followed the salt and sulfur solutions; they are all sulfur oils and, below the oil horizons, the sand is generally filled with salt water. Sulfur deposits are due to the action of volcanic gases; hydrocarbons are derived largely from the igneous rocks; chemical reactions in volcanoes need the co-operation of water and, in fact, steam, charged with carbon dioxid and sodium chlorid, is the mainspring of all volcanic phenomena; the gases of an expiring volcano consist of vapor, sulfurous acid and sulfureted hydrogen, hydrochloric acid and chlorid of ammonium. All these conditions are favorable to the deposits of the hydrocarbons which, associated as they are with volcanic and intrusive phenomena, are believed to be due to inorganic agencies.

The organic oils on epigene waters or springs, rise to the surface by capillary action and buoyancy in a steady flow due to hydrostatic pressure, but the inorganic oils from hypogene sources are forced through the openings under tremendous pressure by the intermittent power of the gas.

CURIOUS IMPORTATIONS.

SOME STRANGE ARTICLES ENTERING THE FOREIGN COMMERCE OF THE UNITED STATES.

RECENT tariff discussions which include the rates of duty on articles almost unknown by name to the general public have illustrated the breadth of scope of the commerce of the United States. The fact that the world is ransacked for articles to contribute to the wants of the American public, and that the American producers and manufacturers in turn supply to all parts of the world articles which are in many instances not considered by the general public as entering international trade, is sharply pointed out by these discussions and the great inquiries which grow out of them.

The great variety of the articles forming the trade of the United States with other countries is illustrated more clearly by the Bureau of Statistics' figures of imports than those of exports, due to the fact that its import record is necessarily stated in terms of the tariff law. The fact that the tariff places rates of duty upon different articles, and that the Bureau of Statistics must state the quantity if possible and the value in all cases of each of the articles or class of articles upon which a separate rate of duty is named requires that bureau to differentiate much more closely in its statement of imports than that of exports. As a result its statement of articles and grades of articles imported contains many thousand items.

A study of this statement, "Imports for consumption," as issued by the Bureau of Statistics and constantly consulted by statesmen in preparing and discussing and acting upon the tariff, shows many curious facts regarding articles included in the import trade of the United States.

Wild animals, for example, imported for zoological exhibitions and scientific and educational purposes, which are permitted to enter free of duty because of their prospective use for educational and scientific purposes, amounted in 1908 to between six and seven thousand dollars; while those imported for other purposes evidently exceeded this sum by far, since the group, "All other animals," aside from cattle, horses, mules, sheep, swine, animals for breeding purposes, and teams of immigrants, still shows a value of over one hundred thousand dollars.

Birds imported in 1908 amounted to over three hundred thousand dollars in value, and while they are not specifically enumerated as to varieties, it is presumed that this group is largely composed of canaries and parrots.

Leeches are also enumerated by the Bureau of Statistics under its general head of animals imported, the total value of the imports of this species in 1908 having been $5,341, in 1907 $6,992, in 1906 $4,494, in 1905 $3,862, in 1904 $3,589, in 1903 $3,240, and in 1902 $2,412—the commerce in leeches being thus of a growing character. The total value of the leeches imported into the United States in the decade ending with 1908 is about $40,000. Leeches, it may be added, are imported free of duty. Snails were at one time enumerated as an article of importation, the records from 1894 to 1898 showing snails imported to the extent of about $5,000; but the snail trade so dwindled, showing only $24 of imports in 1898, that the bureau discontinued its statements of this article.

"Divi-divi" as an article of importation has been the subject of many jests by the humorists during the tariff discussions of Congress, though in fact it is an article of no inconsiderable importance in the tanning industry, the product of a leguminous tree in the West Indies and South America, entering in the form of a pod, and amounting in quantity in 1908 to one hundred and thirty-four thousand pounds, valued at between two and three thousand dollars. The value of the imports of the last decade has aggregated about $85,000. Divi-divi, which does not compete with other grades of material used in tanning, and which is required in the development of certain lines of this industry, is imported free of duty.

Rose leaves are also imported free of duty when brought in in a crude state, the value of the imports of 1908 being but $105, in 1907 $2,137, and in 1906 $5,879, the value of rose leaves imported in the decade ending with 1908 amounting to over $20,000.

The extension of the chewing gum industry and the use of that product among the people of the United States is illustrated by the fact that the importation of "chicle" in 1908, chiefly for use in the manufacture of chewing gum, amounted to more than four million pounds. This article, "chicle," is obtained in southern Mexico from the trunks of the sapodilla plum tree, and the importation of this gum during the last decade has amounted to about thirty million pounds, or about fifteen thousand tons, valued at over eight million dollars.

"Dragon's blood" imported, amounting on the face of the returns to fifteen thousand pounds in 1908 and to over two hundred thousand pounds in the last decade, is of course not in fact dragon's blood at all, but a mere name for a deep reddish resinous substance obtained from a variety of trees in the Orient, especially the east coast of Sumatra, and used as an ingredient in varnishes, stains, and dentifrices. The value of the importation of 1908 was about five thousand dollars, and during the decade about sixty thousand dollars.

Infants' foods also form a considerable item of importation, forty-one thousand dollars' worth in 1908, and during the decade have amounted to nearly a quarter of a million dollars, on which the duty collected amounted to nearly fifty thousand dollars.

"Nux vomica" forms a more important feature of the import trade than would probably be realized by the average individual unacquainted with this particular trade. The Bureau of Statistics' figures show that the importation of nux vomica amounted, in round numbers, in 1908 to three million pounds, valued at fifty-four thousand dollars, while the quantity imported in the decade ending with 1908 amounted to about twenty-five million pounds, valued at over four hundred thousand dollars. This article comes in the form of large round seeds of a tree grown chiefly in southern Asia, and is used in the manufacture of strychnine and certain tinctures and tonics prescribed as medicines, and since it does not compete with any product of the United States, enters free of duty.

"Palladium" is also an article of commerce, though in extremely small quantities, since the quantity of palladium imported in 1908 was but three one-hundredths of one pound. This small quantity, three one-hundredths of one pound, was, however, valued at $21, a pound therefore being worth $700. In other years the quantities imported have been much larger, amounting in 1905 to over ten thousand dollars in value, and in 1904 to more than sixteen thousand dollars in value. This rare metal, associated with platinum, while found in its native state in small quantities in Germany and Brazil, is chiefly supplied from the working over of platiniferous residues of various mints, and is used in the manufacture of astronomical instruments, and by dentists, when alloyed with silver, as a substitute for gold.—The Railway Conductor.

The Panama Canal excavation during April amounted to 3,454,649 cubic yards, place measurement, against 4,062,632 cubic yards during March, the latter record probably being as high as will be attained in the future, unless some reason should arise for pushing the work at a faster rate than has hitherto been considered desirable. The falling off last month was the inevitable consequence of the beginning of the wet season. In the rainless months work progresses under conditions that are impossible during the rains. The necessity for ballasting the tracks of the construction lines does not then exist, and it is not until the beginning of the wet period that track work becomes a serious problem. Moreover, the difficulties of keeping the dumps in shape and other working conditions favorable for a high rate of progress are considerably greater after the middle of April. The decrease in excavation by steam shovels was from 2,535,198 cubic yards in March to 2,137,861 in April; and by dredging from 1,527,434 to 1,316,788. The total amount of excavation since the United States took charge of the work has been 73,000,000 cubic yards, leaving about 101,500,000 cubic yards to be taken out in order to complete the 85-foot level canal. An examination of the figures will show that even at the low average rate of 3,000,000 cubic yards per month the excavation can be finished in about two and a half years.

THE OLYMPIA AERO EXHIBITION.

A REMARKABLY FINE SHOW WITH SOME NOTABLE EXHIBITS.

BY W. S. ASTON.

THE Olympia Aero and Motor Boat Exhibition opened on March 11th and closed on March 18th, and as regards its first and most important motive, it can be written down, without doubt, as the greatest aeronautical show ever held in the eastern hemisphere. The Paris Salon held in September last had the advantage of greater space and surroundings more closely approaching the ideal, but as regards originality, sound design, and constructive workmanship, and also as regards the number of exhibits, it cannot compare with the Olympia show. It has been suggested, and no doubt there is a certain amount of truth in the contention, that the English have not yet learned to take aviation seriously, but the present exhibition will go far to refute that criticism, well merited though it was. The British firms that have taken the matter in hand have left no stone unturned to get well to the forefront of the coming industry, and though the number of British machines which have successfully flown is at present a rather small one, yet it is safe to say, after a closely critical inspection of the aeroplanes on exhibition, that the very great majority, in fact practically all, of the machines shown at Olympia will fly. While a number of the machines are certainly original, they earn the epithet rather for originality in detail than in broad design. Their manufacturers have been wise in turning out something which has a precedent for claiming to fly rather than developing ideas which are not likely to be convincing.

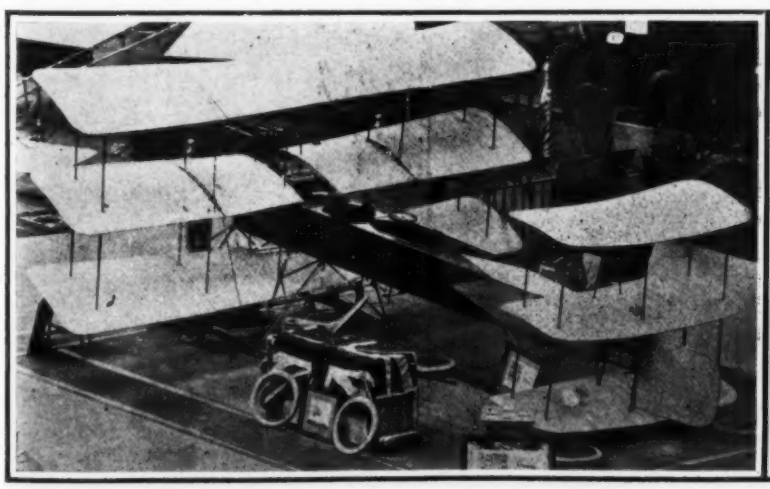
The show embraces some 30-odd complete machines, of which at least 25 can be relied upon to fly, 12 at least having done so already besides a very interesting and instructive model section and several balloons. There is also shown the "Willows" 40-50 horse power dirigible which has already performed in a highly successful manner.

Perhaps the most interesting machine in the show is the "Le-Blon-Delagrange" type of Humber monoplane, of which a photograph is reproduced. In plan and general arrangement it resembles a Blériot XI., but differs chiefly in the body, which consists of a long tapered tube built up of thin wood strengthened with a spiral canvas wrapping. Great strength is thus obtained with extreme lightness. A special feature has been made of the elimination of wires with the excessive resistance they occasion when in a state of vibration. The wings are trussed with flat steel ribbons, and instead of being warped for lateral stability, their rear edges are flexible their entire length, so that the aviator can flex them up or down. This amounts to a variable camber or curve-flattening device, which should make the monoplane very speedy. The flexible rear edges are as in the Blériot machine, interconnected with the rear vertical rudder. They can be worked together also so that a greater curve and increased lift can be obtained for starting purposes. The usual running chassis is used, and the propeller is a single 2 bladed one, driven by a 3-cylinder, air-cooled Humber engine very similar to the Anzani. The gasoline and oil tanks, and the control wires are all hidden in the tubular body, on which the aviator sits with one leg on each side. The spread of this monoplane is 29 feet; its surface, 192 square feet, and its length, 26 feet.

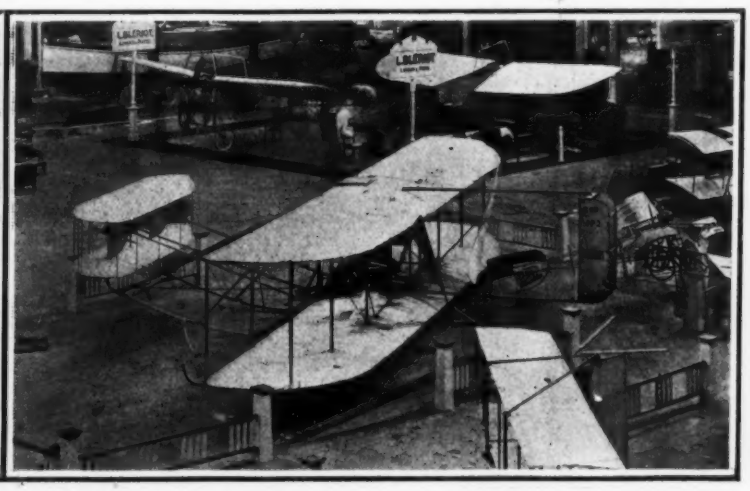
A Humber monoplane, "Lovelace" type, a close copy of the Blériot XI., is shown together with a "Humber Lovelace" biplane, which is practically a Blériot monoplane with a superposed main plane. It carries three passengers, and is driven by a single traction screw on the shaft of a 50-horse-power, 4-cylinder, water-cooled engine.

The George & Jobling biplane has fore and aft control on the lines of the Curtiss, but is full of original points. The control arrangement takes the form of a vertical steering wheel mounted on a pivoted vertical pillar. Moving the wheel bodily toward or from the aviator operates the front horizontal rudder (the tail is fixed), moving it bodily from side to side actuates the side ailerons, and rotating it on its axis turns the rear rudder. It has a single propeller driven by a 50-horse-power Green water-cooled engine. The spread and length are both 30 feet, while the supporting surface is 360 square feet.

The Wright machine made under license by Messrs. Short Bros., upon which the Hon. C. S. Rolls has performed so successfully, winning several prizes, is shown, together with a new Short machine on modified Wright lines. It has a large cruciform tail, the horizontal part of which is movable in conjunction with the front horizontal rudder. A single propeller with a diameter of 7 feet 6 inches, and a pitch of 4 feet 10 inches, is used, and is driven by a 50-horse-power Green engine placed behind and on a level with the head of the aviator, so that the body resistance is reduced to a minimum. The landing chassis is arranged in a rather original manner, and embraces running wheels as well as landing skids. When required, for instance, in landing, the wheels are drawn up about the skids by a ratchet contrivance, and in this way the shock is transmitted over a large surface. The balancing planes between the main planes have a rigid front half, but the trailing edge is attached to a light spar by spiral springs



THE COE TRIPLANE WITH BOAT-SHAPED BODY AND 50-HORSE-POWER ENGINE.



THE HON. C. S. ROLLS'S WRIGHT MACHINE BUILT IN ENGLAND.

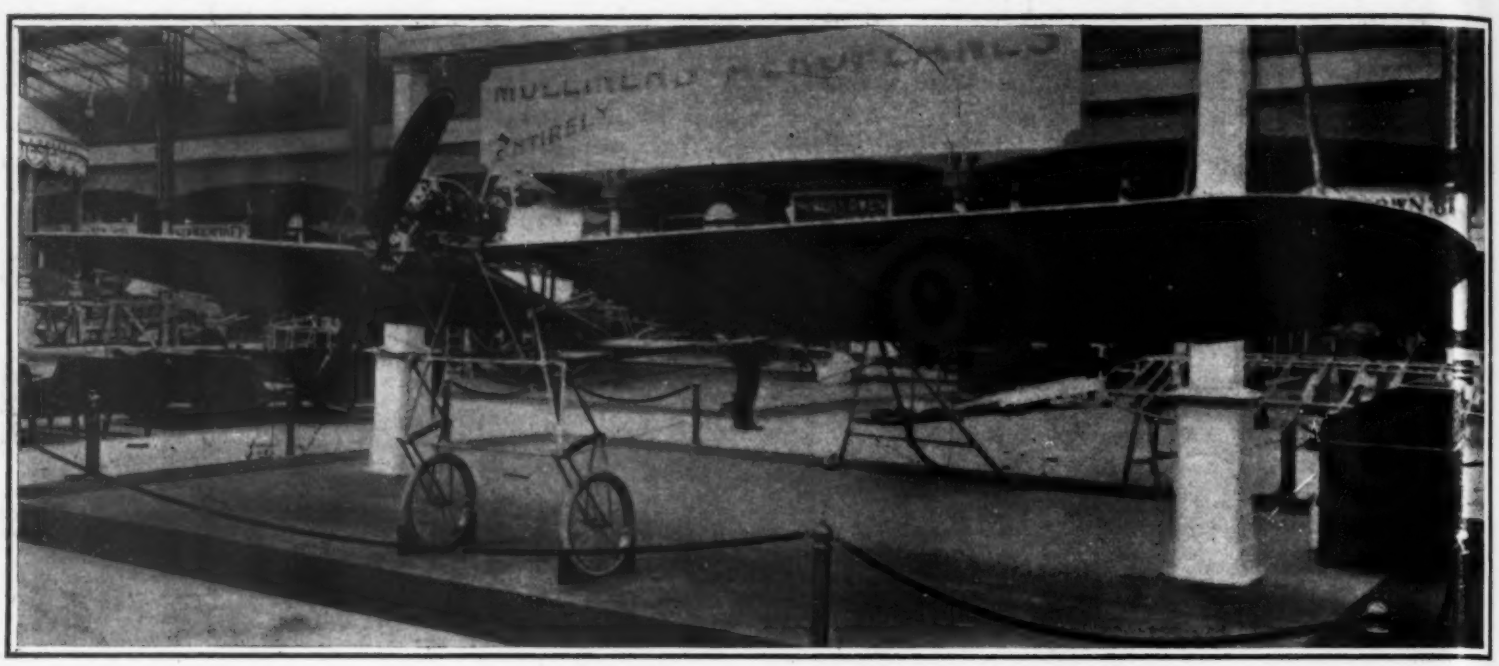
THE OLYMPIA AERO EXHIBITION.

which render it very flexible. This device has been found of great value on the modified Wright triplane, which Short Bros. built for Mr. Moore-Brabazon, on which he won the Daily Mail £1,000 prize for the first Englishman to fly a mile on an English machine. This machine is also shown and is principally notable for the unusual "paper-dart" tail with which it is provided and which is shown on our front page.

machines, while being admittedly imitations, have a number of original details which are, generally speaking, improvements.

A highly interesting production is the Petre monoplane, which, while resembling a Blériot in plan, has a single propeller behind its tail, the screw being driven by a long light hollow shaft carried in a series of ball bearings. The framework is shaped like an

The Star monoplane in general appearance resembles the Antoinette, but it has a peculiar form of tail which is depended upon for the complete lateral and longitudinal control of the machine. This tail is composed of four planes forming two horizontal and two vertical rudders, which when all turned in the same direction form, as it were, a windmill with very slow-pitch blades which has the effect of turning the machine



THE MULLINER MONOPLANE WITH 8-CYLINDER AIR-COOLED MOTOR.

Among those Englishmen who have already flown A. V. Roe has been the most persistent trier and has done some really marvelous performances on a somewhat carelessly built triplane, the power plant of which was a 9-horse-power motorcycle engine. He now shows a beautifully made model on improved lines, of which a photograph is reproduced. During the show he made some capital flights with it at Brooklands. Although the dimensions are the same as those of the original aeroplane, or "avroplane," as he calls it, viz., 60 feet of entering edge, giving a total lifting surface of 210 square feet, he now uses a 50-horse-power, four-cylinder water-cooled Green engine. The fore half of this machine is built on the lines of a yacht's hull, with thin wooden planking, and the total weight in flying order is only 450 pounds.

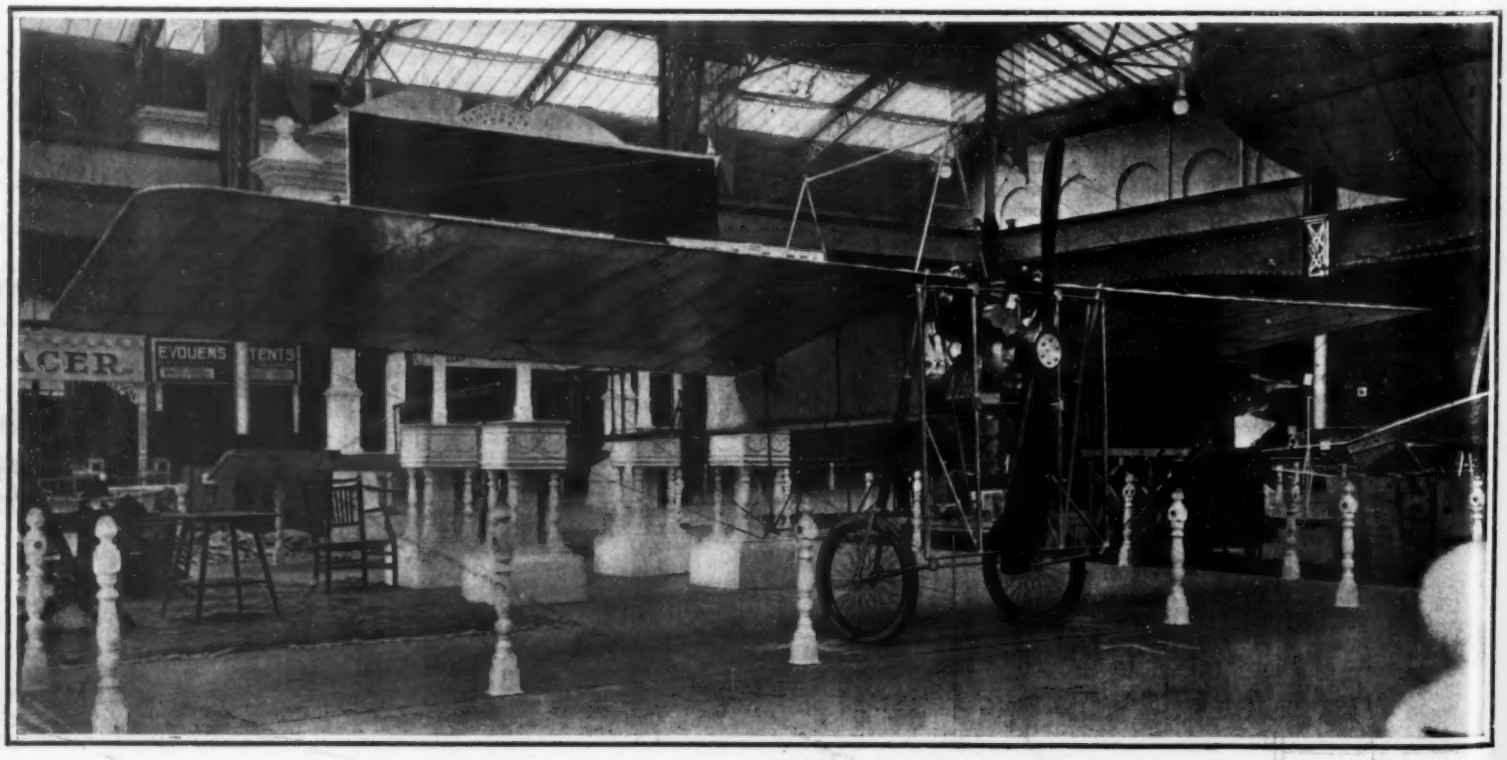
There are, of course, a number of machines closely resembling the Blériot No. XI. monoplane—the cross-channel type. Among them is the Lascelles, with a four-cylinder air-cooled engine with cylinders arranged semi-radially, the Lane, the Holland & Holland, the Howard Wright. Besides these there are two examples of the genuine Blériot shown by Louis Blériot himself and Blériot Ltd., the English agents. Many of the above inverted canoe and the aviator sits in the immediate bows, where he controls the machine either by increasing or decreasing the angle of incidence of the main plane, or altering the tail, or operating ailerons which form the corners of the wings of the main plane.

Although the actual machine is not shown in the exhibition, the A. S. L. monoplane is particularly interesting because it is what may be described as a Wright monoplane, i. e., it flies with its tail first. This monoplane flew highly successfully at its first attempt a week before the show opened and has since performed extremely well.

The Mulliner monoplane is one of the finest pieces of workmanship in the show. The main stringers forming the longitudinal members of the fore body are channeled and drilled like the frame girders of a racing car and are extremely strong and light. The wood used is English ash seasoned by ten years storage. This monoplane is 26 feet long by 33 feet spread, and has a lifting surface of 220 square feet. Its weight in flying order is but 380 pounds. It is driven by an eight-cylinder air-cooled J. A. P. motor, weighing 250 pounds.

about its longitudinal axis when required by circumstances. At the same time the planes forming the vertical rudder can be worked independently of the horizontal tail, as also can those forming the vertical rudder. Whether a recuperative moment can be obtained satisfactorily with the tail in this manner remains to be seen, but a similar machine built with a much smaller engine—the present monoplane has a 25-30 four-cylinder engine—has made several promising short flights.

The Clement-Talbot Co. show a fine example of the Santos-Dumont "Demoiselle," with detachable wings made of the finest grade of silk and constructed with irreproachable workmanship. The spread of the main planes is 17 feet and the depth 5 feet. The engine is a new Clement-Bayard model giving 30 horse-power and having horizontally opposed cylinders with electrically deposited copper water jackets. The body of this machine is entirely of elliptical-section steel tube of great strength and lightness, Santos Dumont's original bamboo frame having been entirely discarded. The control arrangements are of the simplest possible form, the ignition being operated by a string hanging down in front of the driver's face,



THE LASCELLES MONOPLANE DRIVEN BY A 4-CYLINDER AIR-COOLED SEMI-RADIAL MOTOR.

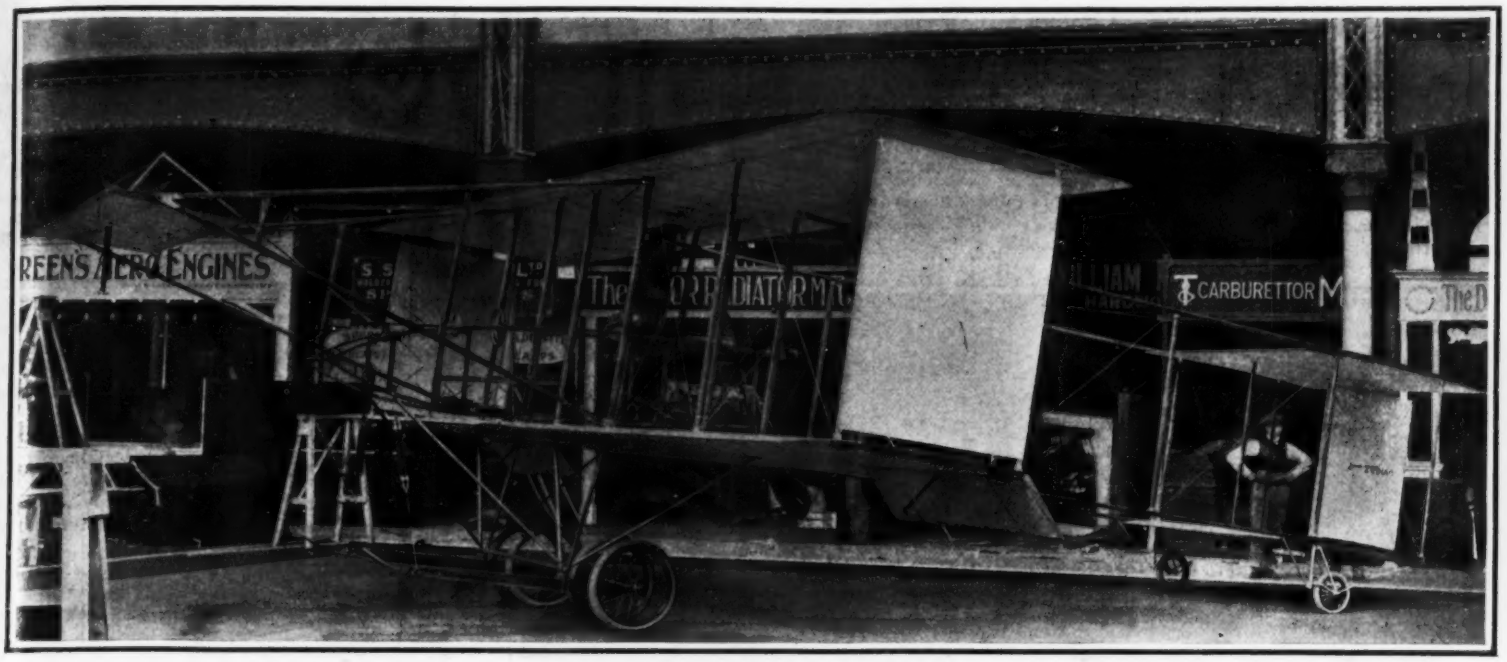
THE OLYMPIA AERO EXHIBITION.

the throttle by a similar string running down and attached to a foot-lever, while the tail, wing warping, and vertical rudder are operated by a lever at each side of the pilot and a drum-wheel on his left side.

The English Darracq Company having obtained the rights of the Farman Company in England shows a Henry Farman biplane with a 40 horse-power double opposed four-cylinder engine.

The N. E. C. engine is of the two-cycle type and is shown fitted to several machines. Already some good flights have been made with this motor which has some unusual features. It works on the scavenging principle, a couple of rotary blowers feeding the cylinders with gas and air, respectively, being attached to each cylinder and the admission being by rotary piston valves.

The Lamplough turbo-motor is a highly original



THE ZODIAC BIPLANE, ONE OF THE LATEST FRENCH TWO-SURFACE MACHINES WITH SEVERAL NOVEL FEATURES.

A new biplane on somewhat similar lines to the Farman is the Zodiac made by the well-known French balloon constructors. This machine has a monoplane tail instead of the usual box construction, and has vertical panels between the planes like the Voisin, but these panels are between the ends of the planes only. A single propeller driven by a 50-horse-power four-cylinder Green engine is used.

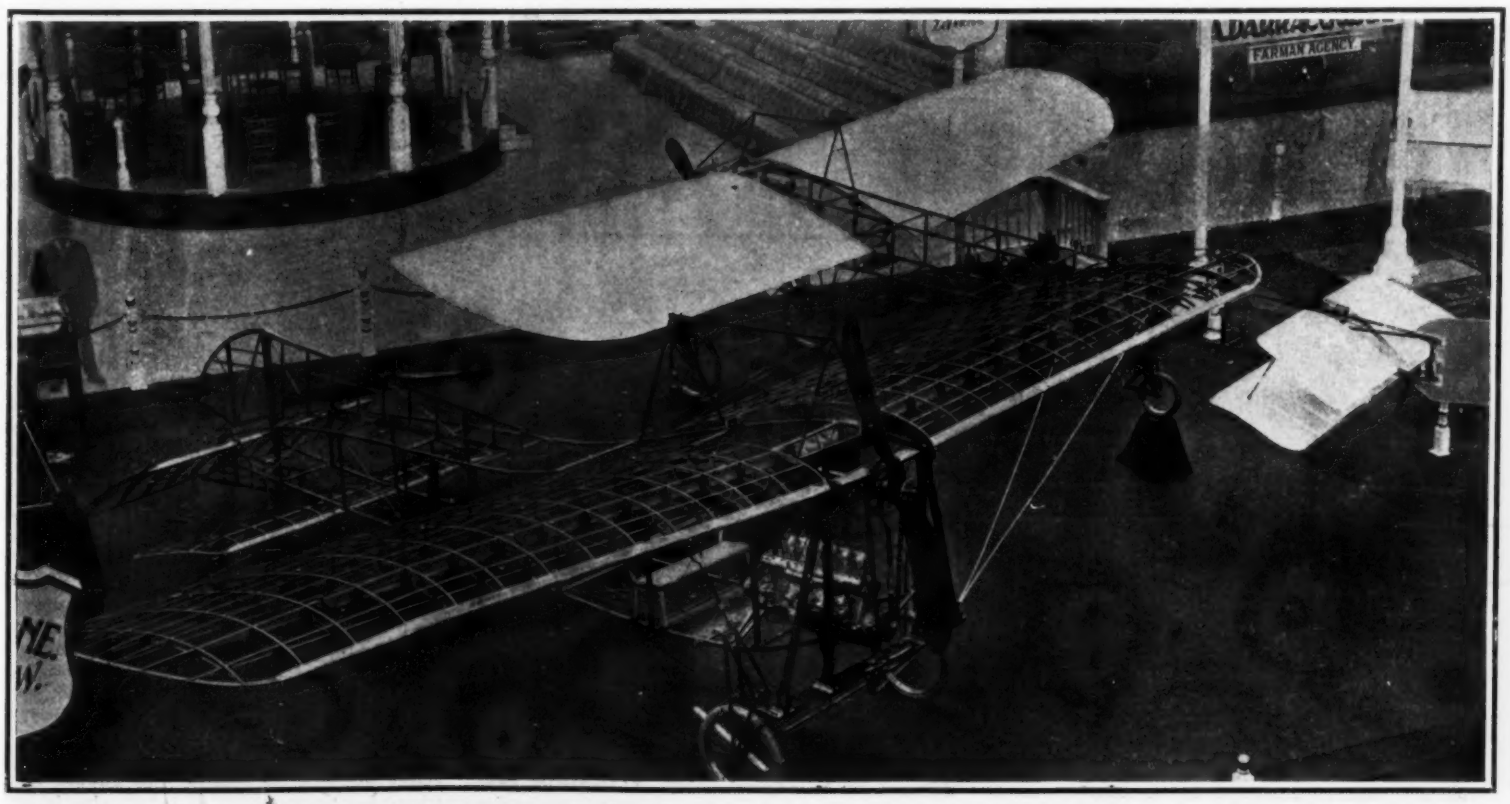
Among the engines shown on various stands are several interesting types in addition to those already touched upon. The Isaacson motor is of the rotary, or Gnome, type, and has its six cylinders arranged radially around a single crank-throw. The cylinders are water cooled, their jackets all being connected up "in series" by a number of circumferential water pipes, forming a rotary radiator, and as the jackets are of ample capacity no water tank is required. All the valves are in the cylinder heads where they are worked by a common stationary cam and the gas is admitted to the cylinders through a star-pipe centered on the hollow crankshaft.

form of engine which has given good results on the bench, although as yet untried in the air. A plate is obliquely and loosely attached to the stationary crankshaft and to this plate are secured, by means of knuckle joints, the connecting rods of the two double-pistoned two-cycle cylinders. As the plate revolves its altering angularity causes the piston to reciprocate, mixture being fed in by direct plunger pumps with pistons articulated to the driving plate. The two working cylinders are air-cooled and a single explosion in each takes place between the two pistons, which work in opposite directions.

There are, of course, a number of other features of interest in the Olympia Aero Show, which it may be noted has been patronized and visited by His Royal Highness the Prince of Wales, but a description of them would require more space than we have at our disposal.

A paper by Dr. F. Mollwo Perkin and Mr. W. E. Hughes, entitled "Studies on the Electro-Deposition of Metals," was read in abstract by Dr. Perkin before the Faraday Society on January 18th. The authors describe a rotating cathode employed for rapid electro-deposition of metals. It consists of sheet platinum spun up so as to form a narrow thimble, the upper end being open and having a stout iridium wire fused to it. This electrode, which has an active surface of 1.3 centimeters, is rapidly rotated within a cylindrical platinum gauze anode. In other cases, particularly when graded potential methods are employed, a spiral anode of platinum is rotated within the gauze cylinder, which then functions as cathode. In the potential measurements a cylindrical glass funnel with a glass tube sealed in the side is employed for holding the electrode.

Fluid Bronze (according to J. E. Stroschein).—Gum dammar is melted, with an addition of about 1-3 anhydrous carbonate of potash or soda, and kept for three days, stirring occasionally in this condition. Then the alkaline resinous mass is to be finely pulverized, spread on trays in thin layers, exposed to a temperature of about 106 deg. F., and left thus for several months. The resin thus obtained is dissolved in benzine or some other petroleum distillate, with a low boiling point—after dry ammonia gas has previously been for a long time passed through the solvent. In the varnish thus obtained, the fine powder, bronze, is stirred; it remains suspended therein, and is then ready for use.



BRITISH-BUILT "LANE" MONOPLANES WHICH RESEMBLE THE BLÉRIOT MONOPLANES. THE SKELETON MACHINE IN THE FOREGROUND CARRIES THREE PEOPLE.

THE OLYMPIA AERO EXHIBITION.

THE SOUTH POLE.

THE COMING ANTARCTIC EXPEDITIONS.

THE years 1910 and 1911 promise to be particularly noteworthy in the annals of Antarctic exploration. On February 1st Commander Peary proposed to the Board of Managers of the National Geographic Society that the Society and the Peary Arctic Club should together send out an expedition to the south polar regions to explore the coast of Weddell Sea and, if possible, reach the South Pole *via* this route. The proposed expedition would leave the United States in August of this year, and cross the Antarctic Circle about January 1st, 1911. Commander Peary offered on behalf of the Peary Arctic Club to place the steamship "Roosevelt," which, it will be remembered, was built by the club especially for polar work, at the disposal of the expedition, provided the society would assume the initial expense of $50,000. He also proposed that expenses above $50,000 be divided equally between the Peary Arctic Club and the National Geographic Society. He estimates the total expense of fitting out and maintaining an expedition in the south polar regions for one year at between $75,000 and $100,000. All of Commander Peary's recent polar equipment, including sledges, fur clothing and camp equipment, would be placed at the disposal of the party.

A British expedition under Captain Scott will leave in August, 1910, and spend the year 1911 in Victoria Land for the purpose of reaching the South Pole. The American party will start exactly opposite the English base.

The United States navy, it is said, may send an expedition to relocate Wilkes Land in the south polar region, a country discovered by an American naval officer, and to take possession of it in the name of the United States.

It has generally been accepted by foreign authorities that d'Urville sighted the land of the Antarctic Continent, which he named Adelie Land, on the same day (January 19th) that Wilkes discovered land 400 miles to the eastward, which he named Cape Hudson, and also that D'Urville's Cote Clarie, in longitude 131 degrees east, was sighted by him the day before it was seen by Lieutenant Ringgold, on board U. S. S. "Porpoise." According to Rear Admiral John E. Pillsbury, U. S. N., in a recent number of the National Geographic Magazine, investigations show that both of these assumptions are in error, and that in fact d'Urville first sighted Adelie Land the day after Wilkes sighted Cape Hudson, and that he sighted Cote Clarie the same day that it was sighted by Ringgold, but at a later hour. Wilkes cruised along the coast of this continent for more than 1,600 miles from his first landfall. Future exploration may, and, indeed, probably will, find that much of the land discovered by him was placed too near the barrier, or, in other words, too far north, for it is well known that distance estimated by the eye is liable to great error, and particularly is this the case in the polar regions.

Wilkes called this land the Antarctic Continent. It must belong to the entire continent the existence of which he revealed. Some geographers have recognized, that the part of Antarctica which he discovered needed a special name and, therefore, gave it the names of Wilkes Land. When it is remembered that Wilkes changed the conception that the Antarctic was an ocean by demonstrating that it is a continent, the least that his discoveries demand is that the name of Wilkes Land be retained on all of Antarctica lying between the longitudes of 95 degrees and 158 degrees east.

"The race for the South Pole will be the most exciting and nerve-racking the world has ever seen," are the words of Commander Peary, fresh from nailing the Stars and Stripes to the Big Nail of the North. Capt. Scott sails next August, and after wintering in McMurdo Sound will start in October, 1911, on his land journey to the pole which he hopes to reach by the end of December. The American Expedition, starting from its base in Coats Land, will do its utmost the same month. The interest in the latest South Polar quest will be enormously enhanced by the sporting character it now assumes.

From the Graphic.

THE QUEST OF THE SOUTH POLE.

The American Museum of Natural History will send an expedition to the South Pole to study extraordinary forms of animal and vegetable life existing there. The expedition will be named in honor of Morris K. Jesup, the late president of the museum.

Lieutenant Shackleton's expedition will probably attract most attention, largely because Shackleton holds the South Polar record. In all likelihood he will go efficiently equipped this time.

Among the more or less fanciful schemes of reaching the South Pole may be mentioned Captain R. V. Webster's illusory idea of reaching the pole in a combined aeroplane and balloon, following the route of Lieutenant Shackleton overland as far as possible at first, and making the final dash in his airship.

It is said that two Russians, Baron Mathiessen and Baron Voltchoeck, will make the attempt with two dirigible balloons. After Wellman's fiasco it seems hardly likely that any such scheme can succeed.

How much truth there may be in the rumor that the Germans will take part in the race for the South Pole, it is difficult indeed to judge.

No region in the world presents such problems for exploration, and the advancement of science as are to be found around the South Pole. Here is a continent greater than the United States and Alaska combined, much larger than Europe, a continent which has been penetrated in only one direction, namely by Scott and Shackleton from Victoria Land. Even its coast lines are little known. It is believed that the greater part of this continent ranges in altitude from 8,000 to 14,000 feet above the sea, making it probably the largest continental mass above sea-level in the world.

Planted on the fringe of this vast continent of snow and ice are lofty volcanoes like Terror and Erebus, which are belching continually smoke and fire. Here lives the most remarkable bird known to science, the penguin, which lays its egg on a cake of ice in the blackness of a polar night, when the temperature is not less than 30 deg. below zero, and then holds the egg and then the chick on its feet until the young bird can take care of itself.

Dense pack ice surrounds the Antarctic area and makes the approach to land difficult from all directions. But the great engines and heavy frame of the "Roosevelt," which is more powerful than any vessel hitherto employed in South Polar work, should enable her to pound a path where previous ships have been helpless, and thus to carry the American party to an advantageous base. Exactly where this base shall be cannot be determined until the party get in the ice and find where they can go, but Commander Peary proposes that the American expedition should make its headquarters somewhere on the coast of Weddell Sea, probably in the vicinity of Coats Land, which was discovered by Captain Bruce, of the Scottish expedition, in 1904. It is hoped that a base can be found here less than 900 miles from the pole.

This particular section is the least known in the Antarctic area. Bruce succeeded in getting within a few miles of the coast, but he did not land. Ahead of him were ice-clad slopes which he believes ascend to a plateau, which may be an extension of Victoria Land. All explorations in this region would be absolutely new discoveries and would benefit geology, zoology, and all kindred sciences.

The chief difficulty to be encountered from the New Zealand side will be the Great Ice Barrier discovered by James Ross in 1840, rising from the sea to an average height of nearly 200 feet, and stretching from King Edward VII Land to South Victoria Land, a distance of about 400 nautical miles. Little is known about this great barrier.

According to Henry Gannett in the National Geographic Magazine, it was not until Scott, in 1902, and Shackleton, in 1907, made their remarkable sledge journeys in the interior of Antarctica that the nature of the great ice barrier became known.

The barrier is simply the southern limit of a great sheet of ice extending southward up a great bay which penetrates the land at least 300 miles and possibly double that distance. Indeed, it is possible that it may extend entirely across, joining with Weddell Sea on the opposite side and dividing Antarctica into two continents. From the barrier southward this bay, with a known area of at least 100,000 square miles, is entirely occupied by this ice sheet. It is bordered on the west by high mountains from which stretches westward a still higher plateau, which reaches an altitude of over 11,000 feet at Shackleton's farthest southern point. The land on the east side of the bay is unknown, except at the point of King Edward VII Land, where the barrier joins it, but it also is probably mountainous.

From the high land on the west side numerous glaciers descend to this field of ice. Notable among them is that by which Shackleton ascended to the summit of the plateau in his wonderful sledge journey toward the South Pole, a glacier 100 miles long and 50 miles wide, with a descent of 8,000 feet. From the east side of the bay, and especially from its south end, probably other great glaciers contribute to the great ice field.

The name "Great Ice Barrier," originally applied only to the ice cliff forming its northern limit, has been extended and applied to the ice field itself, and even to the bay which it covers. It is unnecessary to say that these extensions in the application of the name are inappropriate, and it is to be hoped that suitable names will be selected for these features. I would suggest for the ice field the name of Shackleton glacier, since Shackleton has made the most extensive explorations of it and its surroundings; moreover, I hope to show that it is in truth a glacier, although both Scott and Shackleton refuse to accept that explanation of the phenomenon. It is their belief that it has been formed from snow falling upon its surface much as the sea-ice of the Arctic is formed. But sea-ice nowhere accumulates to any such thickness as this or presents an ice wall at its borders. On the other hand, every glacier that reaches the sea presents just such an ice wall. There are scores of such glaciers on the Alaskan coast, and probably hundreds on Greenland, Grant Land, and Spitzbergen, whose fronts extend out into the sea, even into water so deep that they must be afloat, as is much of the barrier.

The snow which falls upon the surface of this ice field could not possibly supply the waste from the barrier, and another source of supply must be found. This supply is in the numerous and large stream glaciers which bring down the ice from the highlands on the east, west, and south of the bay. The area thus drained must be enormous—amply sufficient to maintain the supply.

The fact that this great ice field is moving northward at the rate of about one-third of a mile a year, as ascertained by Shackleton, would seem in itself as a conclusive demonstration that it is a glacier. Sea-ice, unless driven by wind or currents, is quiescent, while the glacier moves toward lower levels.

Thus Shackleton glacier is a great mother glacier, into which drains the snow and ice from enormous areas of highland. The glacier collects the ice and transports it northward to the Great Ice Barrier, where it is dropped as bergs into Ross Sea.

TO FIND THE SIZE OF A STOP.

A LITTLE practical difficulty often met with by the photographer accustomed to do his own odd jobs in connection with apparatus, is the determination of the right size of a stop. Second-hand lenses are often without any Waterhouse stops, and when the right size for one stop has been found, the diameter of the next one in the usual series generally necessitates the raking up of the old rule for obtaining a square root, which rule few can remember.

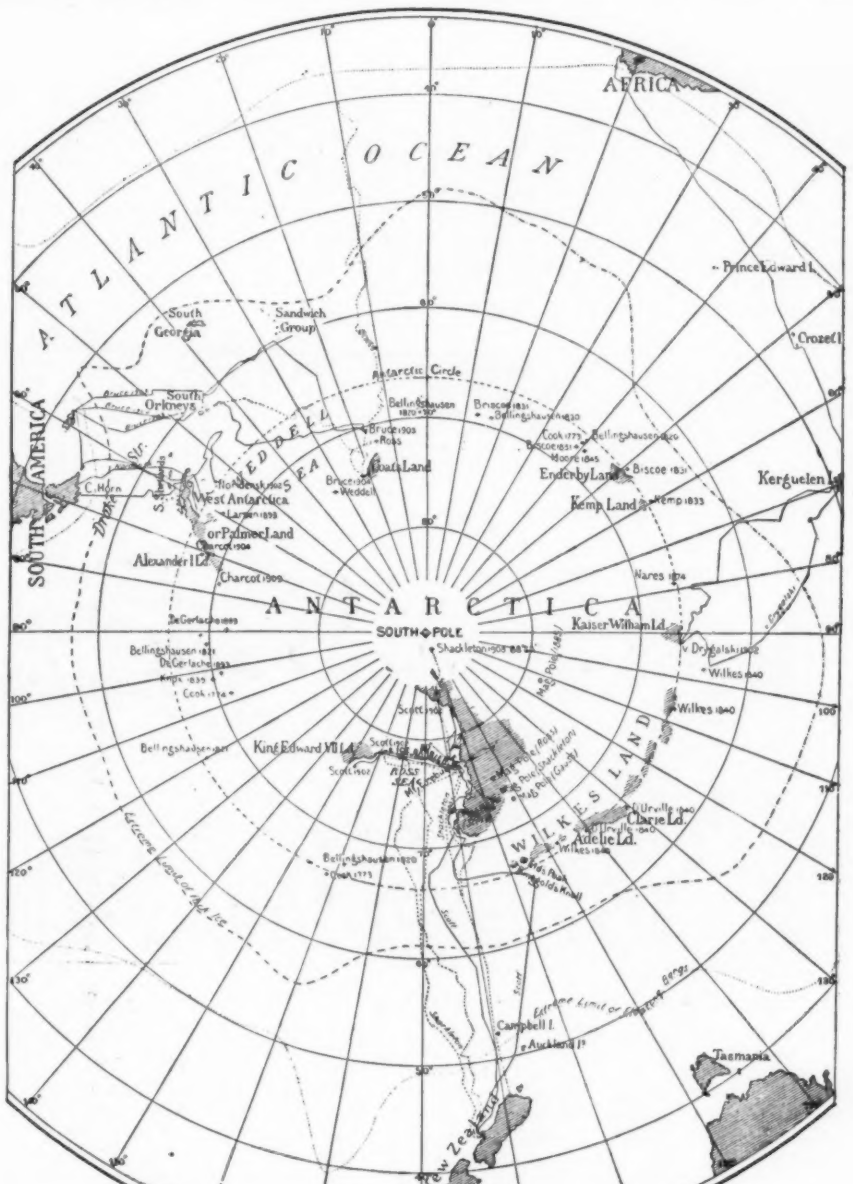
A writer in the Amateur Photographer points out a very simple geometrical method of solving this problem, well known to experienced workers, but not to the amateur camera fitter. This method is an easy application of the familiar forty-seventh proposition of the first book of Euclid, which teaches us that in a right-angle triangle the square on the side subtending the right angle is equal to the sum of the squares on the other two sides. If these other two sides are equal, it is obvious that the square on either one of them is equal to half the square on the longest side.

Therefore, the ratio of one short side to the longest side is that of the diameter of two lens stops, one of which requires twice the exposure of the other. We, therefore, only need to draw a right-angled triangle with two equal sides, making one of these sides equal to the diameter of our known stop. The longest side facing the right angle is then equal to the diameter of the next largest stop. Having fixed two of the diameters, the rest are simple multiples of these two: Thus, if we know the diameter of *f*/11 and find that of *f*/8 by the construction described, *f*/22 and *f*/44 are respectively half and a quarter of *f*/11, while *f*/16 and *f*/32 are half and a quarter of *f*/8.

After a thorough investigation and numerous conferences with railway men, the Indiana Railway Commission has issued an order to all of the railways in the State requiring that all locomotives used for passenger and freight service shall be equipped with headlight lamps of 1,500 candle power. The order does not specify that the lamp shall be electric or acetylene. During the investigation experiments with oil and electric headlights were made in the laboratory of Purdue University. While railway men with few exceptions opposed high-power headlights, electric traction motormen were practically unanimous as to the advantages of high candle-power over the oil lamp. About 4,000 locomotives come under the order, of which one-third are to be fitted by January 1st, 1911, and the remainder by July 1st, 1911.

MYTH AND SCIENCE.

TRADITIONS concerning so-called extinct animals still surviving in little-known regions of the earth's surface are persistent enough to warrant the attention of men of science. Whether, however, the strange creatures spoken of by savages as haunting lonely lakes and forests are really survivals from the pre-glacial epoch is quite another question. According to that great authority on wild animals, Herr Carl Hagenbeck, an animal akin to the Brontosaurus, which is twin brother to the Diplodocus, is still alive in the fever-haunted swamps of Rhodesia, whether northern or southern we are not told. Many years ago the observer Menges, who is a very trustworthy authority, was informed by negroes of the existence of this huge saurian, and a recent writer in the Buluwayo Chronicle mentions the continuance of the tradition and adds many interesting details. Were the late Prof. Seeley, who above all other palæontologists was an authority on South African fossil fauna, still alive it would be interesting to hear his weighty opinion on the subject, if he has not already adverted to it in his book on dragons. The story has so far been treated as a rumor. Only recently private advices reached England that in the dense and gloomy forests of an island in the Malay Archipelago (we believe it is Ceram) there still exist monsters of a species long believed to be extinct. The news first reached Mr. Alfred Stalker, a young collector of natural history specimens, who, we understand, has done good work for leading museums both here and in Australia. Mr. Stalker was told that the monsters would be found two days' march in the interior and that they lived in water. He is said to have postponed his search for them and now the melancholy news reaches us of his death by drowning. It is, of course, possible that the creatures are only tapirs. Readers of Mr. Andrew Lang's whimsical "Disentanglers" will remember that he chose Cagayan Sulu, one of the most southerly of the Philippine Islands, as the habitat of the mystic and mythic "Berbalang." It is to this island that the explorers in his story brought their finds—the giant sloth (mylodon) of Patagonia, the bunyip of Central Australia, the beathach of Loch Odha, the eggs of dinornis, the gorilla, and so forth. Now we know that the mylodon existed in times comparatively recent, for it has been found, and the Daily Express sent out an expedition to investigate the matter not many years ago. The bunyip rests apparently on the authority of Buckley, the convict who escaped from Port Phillip a century ago, lived long as a savage among primitive Australian blacks, and doubtless was the antitype of the ingenious M. de Rougemont, as Selkirk was of Crusoe. Still, huge marsupials of the bunyip type may very well have existed in lagoons in Central Australia to times quite within the memory of persons still living. Sutherlandshire Celts have told Mr. Andrew Lang that in winter nights the beathach, a creature of immeasurable length, has been heard breaking up the ice in the lochs. Perhaps this creature is a dim reminiscence of the Pittsburg diplodocus, the skeleton of which is well known to us in the British Museum of Natural History. The dragons, the kraakens, the many huge serpents of the "Lesser Edda," a work compiled in the snakeless Iceland of the thirteenth century, are doubtless also mere memories lingering for ages in the primitive mind. Of their family is the sea serpent, so solemnly reported upon in 1821 by William Clift, conservator of the Museum of the Royal College of Surgeons of England. This creature was perhaps a manatee. The mammoth, again, was long half mythic. Its tusks were sought for in Siberia, but the whole creature remained unknown until 1803, when the well-preserved body of a mammoth was melted out of a large block of ice on the shore of Lake Oncoul, and, though afterward partially devoured by packs of wolves, was discovered in its entirety by a Tungoose ivory hunter, and in 1806 fully examined by Mr. Adams. The wild hunter at gaze before the mammoth was the subject of one of Ernest Griset's pictures long in the possession of the late Sir Joseph Prestwich in his Shoreham home. To medicine, these strange histories are of considerable interest, though few men of science believe in the possibility of the survival among us of animals belonging to the pre-glacial epoch.—Lancet.



From the National Geographic Magazine.

SKETCH MAP OF THE SOUTH POLAR REGIONS.

SOLAR VORTICES AND MAGNETIC FIELDS.—II.

RECENT STUDY OF THE SUN.

BY PROF. GEORGE E. HALE.

Concluded from Supplement No. 1787, Page 215.

I have already referred to the importance of applying in astronomical research the methods of the physicist. During the last quarter of a century the study of spectroscopic phenomena in the laboratory has been completely transformed. It may well be said that this transformation, which has involved such discoveries as spectral series, the effect of pressure on wave-length, and the Zeeman effect, has been directly due to the use of Rowland's concave gratings, of good focal length, arranged for photography. In astronomical spectroscopy great advances have also been made, but the spectroscope has continued to occupy the place it formerly held as an attachment of the telescope. Although Rowland used a long-focus concave grating for his classic study of the solar spectrum, the heliostat and lens employed with this instrument gave so small a solar image on the slit that the investigation of sun-spots and other details was impossible. We thus see that while in the observatory the spectroscope continued to be used as an accessory of the telescope, in the laboratory the parts were exchanged and the telescope was employed simply as an accessory of the spectroscope. It seemed obvious that a great opportunity for advance lay open to the investigator who would combine a long-focus spectroscope with a long-focus telescope. As it would be difficult, or perhaps impossible, to use for photography a sufficiently long spectroscope attached to the tube of an equatorially mounted telescope, some form of fixed telescope was plainly essential.

The tower telescope on Mount Wilson (Fig. 5) is designed to accomplish this purpose. It consists essentially of a 12-inch refracting telescope, of 60 feet focal length, mounted in a fixed position, pointed directly at the zenith. The telescope tube is replaced in this case by a light steel tower. The 12-inch objective lies horizontally at the summit of the tower, and sunlight is reflected into it from the second of two adjustable plane mirrors. The first of these mirrors is mounted as a cœlostat, and is rotated by an accurate driving-clock about a polar axis at such a rate as to counteract the apparent motion of the sun. Thus a beam of sunlight is reflected from the cœlostat mirror to the second mirror, which sends it vertically downward through the objective. In the focal plane, 60 feet below the objective, an image of the sun, about 6.6 inches in diameter, is formed on the slit of a spectrograph, at a height of about 3 feet above the surface of the ground. After passing through the slit, the light of any desired portion of the solar image (a sun-spot, for example) descends vertically into a well about 30 feet deep excavated in the earth beneath the tower. Thirty feet from the slit the diverging rays encounter a 6-inch objective, through which they pass. After being rendered parallel by the objective, the rays fall upon a Rowland plane grating, ruled with 14,438 lines to the inch. The grating breaks up the light into a series of spectra, and the rays are returned through the same objective, which brings the spectra to a focus at a point near the slit. By inclining the grating at a small angle, the image of the spectrum is made to fall at a point slightly to one side of the slit, and here the photographic plate is placed. Thus a portion of the spectrum, 17 inches in length, can be photographed in a single operation. In the work on sun-spots, most of the photographs are taken in the third order of the grating, where the dispersion and resolving power are very high. When the spot spectrum is being photographed, only the light from the umbra is admitted to the slit. At the end of the exposure this portion of the slit is covered, and light from the photosphere, at a point removed from the spot, is admitted to the slit on either side. Thus the narrow spot spectrum is photographed between two strips of solar spectrum, used for comparison.

The advantages of this combined form of telescope and spectrograph are considerable. On account of the great thickness (12 inches) of the mirrors, the height of the cœlostat above the heated earth, and the use of a vertical beam, the definition of the solar image is always better than the Snow (horizontal) telescope. Another important advantage is the nearly constant temperature at the bottom of the well, where the grating is placed. This permits long exposures to be given, when necessary, without danger of such displacements of the spectral lines as would be caused by expansion or contraction of the grating. The grating used in this spectrograph is a small one, which I have employed in most of my work since 1889, but the unusual focal length of the spectrograph permits the full visual resolution of the grating to be utilized in photographic observations. Thus it has become possible to photograph the widened lines and doublets, as well as a host of narrow lines, most of them due to chemical compounds, which had not previously been recorded in the spot spectrum.

Lack of time prevents me from discussing in this lecture the various studies of sun-spot lines carried out with this instrument before the attempt to detect a magnetic field in spots was undertaken. An extensive catalogue of these lines is nearly complete, a preliminary map has been issued and a better one is in preparation, and a series of investigations with the arc and electric furnace has suggested that the strengthening and weakening of certain lines is due to a reduction in the temperature of the spot vapors. At present we are concerned with the cause of the widening and doubling of spot lines, and the method of testing this question must now be described.

A Nicol prism was mounted above the slit of the spectrograph, and just above this a Fresnel rhomb, if the components of a spot doublet were circularly polarized in opposite directions, passage through the rhomb should give two plane polarized beams, the planes of polarization making an angle of 90 deg. with each other. Thus in one position of the Nicol one of the components should be photographed alone, and by turning the Nicol 90 deg. this should disappear and the other component come into view.

When this test was applied with the tower telescope, in June, 1908, the true character of the spot doublets became apparent (Fig. 6). One or the other component of the doublet could be cut off at will by rotating the Nicol, precisely as Zeeman had done in the laboratory. On account of the unique character of the Zeeman doublets, this test alone was almost sufficient to prove the existence of a magnetic field in sun-spots. But one of the great beauties of the Zeeman effect is its many-sided character, which permitted the test to be multiplied and extended. From Zeeman's first experiments it was known, for example, that if the strength of the magnetic field is insufficient to separate completely the components of a doublet, the edges of the resulting widened line should be circularly polarized in opposite directions. Thus those lines which are widened, but not doubled, in spots might be expected to shift in position when the Nicol is rotated. This was found to be the case. Again, the lines which constitute the flutings of the spectra of compounds are not, in general, affected by a magnetic field. Hence such lines in the spectrum of a sun-spot should not be shifted when the Nicol is rotated. This, also, was found to be true. But a still more satisfactory test was suggested by another laboratory phenomenon. When a doublet is observed along the lines of force, with one of the components extinguished by the Nicol, reversal of the current through the magnet should extinguish the visible component and cause the invisible one to appear. In the sun, according to our hypothesis, reversal of the direction of revolution in a vortex should correspond to reversal of the current through the coils of a magnet. Hence the red component of a doublet should appear in the spectrum of a vortex rotating in one direction, the violet component in that of a vortex rotating in the reverse direction. Fortunately, the appearance on opposite sides of the solar equator of two spot vortices rotating in opposite directions (Fig. 4) made this test possible. The results were perfectly in accord with the hypothesis.

So far we have been considering only such phenomena as are observed parallel to the lines of force of a magnetic field; but a spectral line which, in such circumstances, appears as a doublet is usually transformed into a triplet when the observation is made at right angles to the lines of force. The circularly polarized side components of the doublet give place to plane

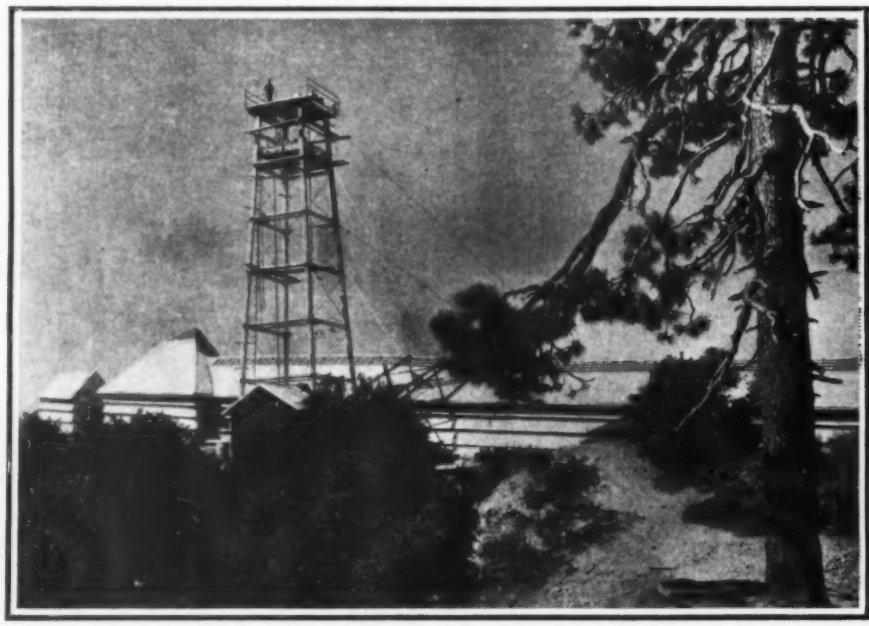


Fig. 5.—TOWER TELESCOPE ON MOUNT WILSON.

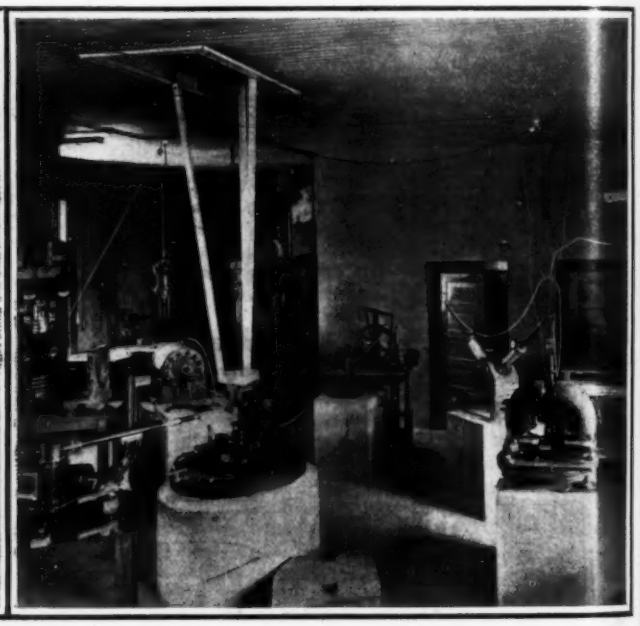


Fig. 7.—INTERIOR OF PASADENA LABORATORY.

View showing slit-end of vertical spectrograph and magnet used in the study of Zeeman effect.

polarized components, occupying the same position, while another line appears, centrally between them. The light of this line is also plane polarized, the direction of the vibration being parallel to the field, while the vibrations of the side components are in a plane at right angles to the field. Thus when a spot is carried by the solar rotation to a point near the limb we might expect the double lines in its spectrum to be transformed into triplets if produced by a magnetic field. The failure of the central line to appear seemed to raise an important argument against the magnetic hypothesis.

At this point the necessity of conducting laboratory investigations in immediate conjunction with astronomical observations is well illustrated. Fortunately, our laboratory was already well equipped for work of this nature (Fig. 7). In anticipation of the possibility that observations of the Zeeman effect would be needed in the interpretation of solar and stellar phenomena, a powerful electromagnet, with suitable accessory apparatus, had been provided. A brilliant spark, produced between metallic electrodes in the field of the magnet, furnished the source of light. As many of the double lines in sun-spot spectra are due to iron, this metal was selected for the first experiments. The spectrum was photographed, at various angles with the lines of force, with a powerful spectrograph, like the one used with the tower telescope, similarly mounted in an underground chamber.

The difficulty of accounting for the behavior of the iron doublets in the sun was removed by these investigations. It appears that these lines do not become triplets when observed across the lines of force. In reality they are changed to quadruplets, or doublets in which each of the components is a close double line. In the magnetic field of sun-spots, which is much weaker than the field used in the laboratory, the closely adjoining lines which constitute the components of the doublets cannot be separated. Thus these sun-spot lines should appear double at whatever position the spot may occupy on the sun's surface.

The distance between the components of doublets or triplets separated in the magnetic field varies greatly for different lines. Some exceptional lines are not affected in the least, others are merely widened, and others are clearly and sometimes greatly separated. It is therefore important to compare the widening and the separation of lines in a sun-spot spectrum with the corresponding phenomena in the magnetic field. With few exceptions, most of which may be accounted for by the presence in the spot spectrum of closely adjoining lines of other elements, the solar and laboratory results were found to be in good agreement. The following table gives a comparison of certain iron lines in the spot and laboratory:

Wave-Length.	$\Delta\lambda$, Spark.	$\frac{\Delta\lambda, \text{Spark.}}{5.1}$	$\Delta\lambda$, Spot.	
6213.14	0.703	0.138	0.136	−0.002
6301.72	0.737	0.144	0.138	−0.006
6302.71	1.230	0.241	0.252	+0.011
6337.05	0.895	0.175	0.172	−0.003

The column headed "$\Delta\lambda$, Spark," gives the distance between the components of the lines as observed in the laboratory. As the strength of the magnetic field used in the laboratory was about 5.1 times that of the spot, the quantities obtained by dividing the separations in the second column by 5.1 are given in the third column. These separations are directly comparable with the separations of the corresponding lines in the spot, which are given in the fourth column. The fifth column shows that the differences between the solar and laboratory results are very small. As the strength of the field in the laboratory was about 15,000 gausses, the strength of the field in this spot would be about $15{,}000 \div 5.1 = 2900$ gausses. The strongest field hitherto measured on our photographs of spot spectra is about 4500 gausses, corresponding to a considerably greater separation of the lines (Fig. 8).

When a similar comparison was made for various lines of titanium and chromium, a much less perfect agreement between the spot and laboratory results was found. It had already been observed that such lines as *D* of sodium and *b* of magnesium, which undoubtedly represent a much higher level than the great majority of lines in the spot spectrum, are but very slightly widened. As these lines are strongly affected by a magnetic field in the laboratory, it appeared evident that the strength of the field in spots must fall off rapidly in passing outward through the spot vapors. In these circumstances lines of other elements, which represent levels higher than the average, should show small separations in the magnetic field of the spot. It seems probable that in this way the lack of perfect agreement between the laboratory and solar results observed in the case of titanium and chromium can be accounted for.

A further important test was afforded by the well-known phenomenon exemplified in Preston's law. According to this law, the distance between the components of the lines split up by a magnetic field varies directly as the square of the wave-length. This we found to be true even in the case of a metal like iron, the lines of which cannot be grouped into series, if the average separation of a sufficient number of lines were considered. We should therefore expect that the widening of lines in spots would rapidly decrease toward the violet, and that the separation of spot doublets should diminish in a similar way. A study of the spot spectrum shows that this actually occurs.

It soon appeared that the normal spot spectrum always contains triplets as well as doublets (Fig. 8). These are less easily recognized, because the presence of the central line crowds the components so closely

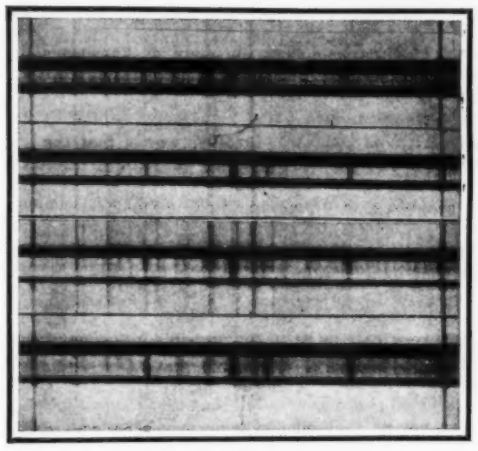


FIG. 6.

1. Southern spot, showing red components of doublets. Nicol, 29° W. 2. Northern spot, showing violet components of doublets. Nicol, 29° W. 3. Northern spot, showing red components of doublets. Nicol 61° E. 4. Spot spectrum without Rhomb or Nicol, showing both components of doublets.

together that they are not readily separated with the resolving power available. As these triplets are photographed, even when the spot is very near the middle of the sun, it is evident that the spot always sends out light which makes a considerable angle with the lines of force. In a normal triplet the central line is of twice the intensity of the side components, when observed at right angles to the lines of force, and disappears altogether when observed parallel to the lines of force. Thus by determining the relative intensities of the central and side lines of such a triplet, the angle between the lines of force and the line of vision can be obtained. In the case of sun-spots, the data at present available are not sufficient for the accurate determination of this angle, but it seems to lie between 30 deg. and 60 deg. when the spot is near the center of the sun. On the hypothesis that the magnetic field is produced by the spot vortex, it would then follow that the axis of the vortex, instead of

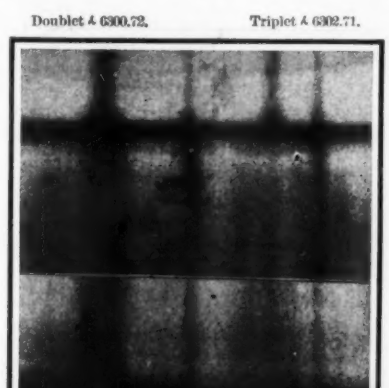


FIG. 8.

Iron doublet (λ 6301.72) and triplet (λ 6302.71) in two spot spectra, showing field strengths of 2900 and 4500 gausses respectively.

being radiant, as we at first assumed, makes an angle of much less than 90 deg. with the surface of the photosphere.

The time at my disposal permits me to describe, briefly, only a few other phases of this investigation. In the laboratory the central line of triplets is polarized in a plane parallel to the magnetic field. Hence, if the light is passed through a Nicol prism, used without a rhomb, it should be possible to extinguish this line at certain positions of the Nicol, in which case a spot triplet would appear as a doublet. This test has also been applied to the spot triplets, with the expected result. In fact, this method supplies a convenient means of recognizing close triplets, the components of which are too closely crowded to be seen separately before the central line is cut out. Indications have also been obtained of what may prove to be unequal rotation of the plane of polarization of this central line in different parts of spots. The gradual decrease in the strength of the field from the umbra to the outer limit of the penumbra has been studied, and magnetic fields have been detected on the sun's disk, in certain regions outside of sun-spots. It is evident that many new phases of the subject are likely to be developed in the future, especially if larger images of the sun and more powerful spectrographs are employed. In this connection it may be stated that a tower telescope of 150 feet focal length, to be used on Mount Wilson with a spectrograph of 78 feet focal length, is now under construction. This will give a focal image of the sun about 16 inches in diameter, in which small spots, as well as large ones, can be studied.

Although it now seems to be demonstrated that sun-spots are electric vortices, judgment should be reserved as to the various theories which have been advanced to account for their origin. Many of the results I have described appear favorable to Emden's solar theory, but it seems to be opposed by the important investigations of Evershed, who has found that the metallic vapors in sun-spots flow radially outward from the umbra parallel to the photosphere. The further development of Evershed's work, and the continued study of solar vortices and magnetic fields, should soon permit a trustworthy theory of sun-spots to be formulated.

It is evident that the rapid decrease upward of the strength of the field in spots would prevent this field from having an appreciable influence on the higher solar atmosphere. At the distance of the earth, as Schuster has shown, the combined magnetic effect of several spots, all assumed to be of the same polarity, and having no such rapid decrease in field strength at higher levels as is actually observed, would be altogether incompetent to account for terrestrial magnetic storms.

In concluding I wish to express my appreciation of the assistance I have received from my colleagues at Mount Wilson. I am particularly indebted to Messrs. Adams, Ellerman, King, Nichols and St. John for aid in connection with the present investigation.

GEESE THAT GROW ON TREES.

THE barnacle or bernicle goose (*Branta bernicle*) is a sea-fowl which rests and breeds on the coasts and islands of both hemispheres between 60 and 80 degrees of north latitude, and appears in great flocks in the Baltic and North seas in spring and autumn. In the Middle Ages this bird was asserted to be a vegetable product. This absurd fable is of Oriental origin. It first appeared in Europe in the "Otia imperialia," or "Idle Hours," written by Gervase of Tilbury, about the year 1211. Gervase asserts that bernicle geese are not hatched from eggs, but grow on trees, and describes a variety of willow, growing on the shore of Kent, near Faversham Abbey, which produces knots that develop into geese. The birds hang suspended by their bills until they come to life and then drop off and plunge into the sea. Hence the flesh of the bernicle goose was eaten freely in Lent for centuries, and even after the Dutch traveler Gide Vera, in 1599, described the breeding places of the birds, which he had discovered in Spitzbergen. According to another fable, which was reiterated with equal persistency, and which has given this much maligned bird its popular name, it passed its early life in the form of a cirriped mollusk, the goose mussel or duck barnacle (*Lepas anatifera*), which clings in vast numbers to the bottoms of ships and greatly diminishes their speed.

A note in the Electrician refers to some tests on electric rolling mills carried out by Mr. Puppe, who has recently published results of accurate electrical measurements he has made on six electrically-driven rolling mills. He arrived at these results by observing the energy given out at the mill and the speed of rotation, and by this means, by also taking into account the copper and no load losses, he was able to calculate the useful work performed. The influence of temperature on the resistance of the material is exhibited by the increase of the latter as the billet cools. Large rolls require more energy with a small height of roller than do small rolls with a large height of roll. The strength of the material has no influence on the energy consumption, but this latter is increased from the fact that the harder the material the lower the temperature at which it must be worked. A drop in temperature of 70 deg. causes an increase in the energy consumption amounting to between 20 and 30 per cent. The spread of the material in a horizontal direction has a disadvantageous effect on the energy required. With a small number of passes the aggregate load on the motor is only from one-quarter to one-fifth of its total capacity, but this is much more when there are many passes and the billets are wide.

HALLEY'S COMET.—I.*

BY FAR THE MOST INTERESTING OF THE PERIODIC COMETS.

BY GEORGE F. CHAMBERS, F.R.A.S.

THE comet known as Halley's may be regarded as by far the most interesting of all the comets recorded in history; and this, whether looked at from the standpoint of the historian or of the astronomer; and having regard to the position which it has occupied during many centuries in the public mind, and is likely also to occupy during the year 1910, it will be worth while to review its career in some detail.

A few years after the advent of the celebrated Comet of 1680 Sir I. Newton published his epoch-making "Principia," in which he first promulgated the Theory of Gravitation, and applied it to the orbit of that comet. He explained the method of determining by geometrical construction the visible portion of the path of the comet, and invited astronomers to apply these principles to the comets on record, or some of them. He considered that it was very probable that some comets might move in elongated ellipses which near perihelion would scarcely be distinguishable from parabolas; and he even thought that the recent Comet of 1680 might be moving in an ellipse the circuit of which would occupy about 575 years. Halley (to whose exertions the publication of the "Principia" was in great measure due, for he bore the labor and expense of its publication) also took this view. Although we now know that the period of that comet is measured by thousands of years, Halley's investigations were not without good fruit, for they may be said to have drawn him into a systematic study of cometary orbits which ended, as we shall soon see, in a famous and remarkable prediction. He undertook to investigate the movements of a large number of comets previously recorded, with the view of ascertaining whether any, and if so, which of them had appeared to follow the same path. Careful investigation soon showed that the orbits of the comet of 1531 and 1607 were similar to each other, and similar in fact to that of the Comet of 1682 seen by himself.

On August 15th, 1682, Flamsteed's assistant at the Royal Observatory, Greenwich, discovered a comet. A few days later the diameter of the head was about 2 min. of arc, and it had a tail 5 deg. long. On August 21st the tail had become 10 deg. long. Flamsteed's observations seem not to have extended beyond September 9th, when the head had become enfeebled and was scarcely visible in the twilight. Halley himself, however, saw it a day later. Picard at Paris found the comet on August 26th, the head shining as a star of magnitude 2. On August 29th the tail was curved, the concavity being on the east side. On September 11th the head was so confused that it was only with difficulty that a luminous point could be perceived. Picard's last observation was on September 12th. Hevelius at Dantzig says that the comet was bright at the end of August, and could be seen all night with a tail from 12 deg. to 16 deg. long. In large telescopes a nucleus of an oval or gibbous form was constantly noticed. It was also remarked that on many occasions the direction of the tail was not exactly *from* the sun, as P. Apian's observations of earlier comets suggested. The most remarkable of the matters mentioned by Hevelius was the existence of a luminous ray, or sector, thrown out from the nucleus into the tail. He has left behind a picture of this.

This ray was first noted about September 8th, and even making every allowance for the vagaries of the astronomical artists of the 17th century, it is impossible to doubt that some sort of ray of light was thrown out from the head of the comet, and we shall presently see that the same thing happened in 1835. The Comet of 1682 seems to have been very generally observed by all the principal astronomers of the time, and among those who have left behind them observations we find the familiar names of Kirch of Leipzig, and Montanari of Padua, and the less familiar names of Zimmermann of Nuremberg and Baërt of Toulon.

Halley, making use of Flamsteed's observations, calculated parabolic elements of the comet in accordance with the rules laid down by Newton; and having also determined by the same methods the orbits of the Comets of 1531 and 1607, he was immediately struck by their similarity, and suspected from "the like situation of their planes and perihelions that the comets which appeared in the years 1531, 1607, and 1682 were one and the same comet that had made three revolutions in its elliptical orbit." This supposition implied that the comet's period was somewhere about 75½ years. There were, nevertheless, two circumstances which might be supposed to offer some difficulty, inasmuch as it appeared that the intervals between the successive returns were not precisely equal, and that the inclination of the orbit was not exactly the same in each case. Halley, however, "with a degree of sagacity which, considering the state of knowledge at the time, cannot fail to excite unqualified admiration, observed that it was natural to suppose that the same causes which disturbed the planetary motions would likewise act on comets." In other words, that the attraction of the planets might be expected to exercise some disturbing influence on the motions of comets. The discrepancies already pointed out in the orbits of the three comets just mentioned made Halley hesitate for some time as to their identity, and in his memoir on comets published in 1705 he only, as it were, hinted his suspicions. Eventually, however, he became much more confident. This appears to have been the result of his investigations as to the probable influence of the planet Jupiter. He found that between 1607 and 1682 the comet had passed so near Jupiter that its velocity in its orbit must have been considerably augmented, and its period, consequently, shortened. He was therefore induced to *predict* its return about the end of 1758 or the beginning of 1759. Finally, when he had matured his labors, he thus plaintively wrote on the

EDMUND HALLEY.

subject: "Wherefore if it should return according to our prediction about the year 1758 impartial posterity will not refuse to acknowledge that this was first discovered by an Englishman." On this Hind judiciously remarked as follows: "Nor has posterity attempted to deprive him of the honors which were his due. His discovery forms an epoch, and an important one, in the history of astronomy. His calculations must have been laborious in the extreme. He assures us himself they were 'prodigiously' long and troublesome; but the zeal which induced such an amount of exertion was well rewarded by the final result."

Halley's first formal announcement of his expectations concerning his comet appears to have been in the paper presented to the Royal Society, in which the following passage (in Latin) occurs: "Now many things lead me to believe that the Comet of the year 1531, observed by Apian, is the same as that which, in the year 1607, was described by Kepler and Longomontanus, and which I saw and observed myself at its return in 1682. All the elements agree, except that there is an inequality in the time of revolution; but this is not so great that it cannot be attributed to physical causes. For example, the motion of Saturn is so disturbed by other planets, and especially by Jupiter, that this periodic time is uncertain, to the extent of several days. How much more liable to such perturbations is a comet which recedes to a distance nearly four times greater than Saturn, and a slight increase in whose velocity could change its orbit from an ellipse to parabola? The identity of these comets is confirmed by the fact that in the summer of the year 1456 a comet was seen, which passed in a retrograde direction between the Earth and the Sun, in nearly the same manner; and although it was not observed astronomically, yet, from its period and path, I infer that it was the same comet as that of the years 1531, 1607, and 1682. I may, therefore, with confidence predict its return in the year 1758. If this prediction be fulfilled, there is no reason to doubt that the other comets will return."

Halley died in 1742 and was buried in the Churchyard at St. Margaret's, Lee, not far from Greenwich, and it has lately (1909) been announced that the Admiralty have decided to repair his tomb at the public expense, no descendants of his being known. The original top slab with an inscription was illegally removed to the Greenwich Observatory in 1854. Let us hope that it will be now restored, or a new one with the original inscription put in place.

As years rolled on and 1758 began to draw near astronomers naturally recalled Halley's prediction, and thought it worth while to rely upon it in making preparations to receive the comet. The French astronomer Clairaut was the man who took the matter most seriously in hand, the important question being to ascertain the extent of the perturbations of the comet's orbit likely to be brought about by the influence of Jupiter and Saturn. The history of the steps taken cannot be better described than in the words of Hind: "Having devised a method which appeared to possess all needful accuracy, he commenced, in conjunction with the celebrated Lalande and a lady, Madame Lepaute, the immense mass of calculations requisite for the complete attainment of his object. It was necessary to compute the distance of the comet from the disturbing planets, Jupiter and Saturn, not only from 1682, when it was last observed, but for the previous revolution, or for a space of more than 150 years. This of itself was a most laborious business; but the succeeding part of the work, where the disturbing force of each planet was required for this long period, involved much greater and more intricate calculations. Lalande minutely describes the plan adopted: for six months they computed from morning to night, with but little intermission, even, as he states, at meals; and he mentions, as one result of this assiduous attention to the work, that he contracted an illness which remained upon him during the rest of his life. Madame Lepaute's assistance is said to have been so important, that without it they would hardly have completed the investigation before the comet reappeared. However, by dint of these extraordinary exertions, the calculations were brought to a close."

On November 14th, 1758, Clairaut announced in a paper addressed to the Academy of Sciences at Paris, that by the influence of Jupiter the comet would be retarded 518 days, and that to this must be added 100 days due to Saturn, so that the total retardation would be 618 days, or about 20 months. On this basis he predicted April 13, 1759, as the date of the coming perihelion passage. He did this, however, with a slight reservation, because, having neglected some small quantities in the calculations, he thought that the date named might be wrong by a month either way. When Clairaut's conclusions became generally known the astronomers of Europe were soon on the *qui vive*, and several of them carried out a prolonged watch of the heavens, which in Messier's case extended over the whole of the year 1758. It was not destined, however, that a professional astronomer should be the first to detect the comet on its anticipated return; that honor was reserved for an amateur student of nature, said to have been a farmer by occupation, named Palitzsch, living at Prohlis, near Dresden, who saw it on the night of Christmas day, 1758, with a telescope of 8 feet focus. Some curious misstatements respecting this man have been widely circulated, and perhaps even to this day may be considered as still in circulation. Baron de Zach, who was personally acquainted with the man, has left on record some interesting particulars relating to him. Farmer though he was, he was a diligent student of astronomy; was possessed of a strong sight; and was in the habit of scrutinizing the heavens with the naked eye, which may perhaps have given rise to the statement that he found Halley's Comet with the naked eye at a time when the professional astronomers were vainly searching for it with their telescopes. The first man of note to find the comet appears to have been Messier, who caught it in bad weather on January 21st, and observed it regularly for three weeks. It seems that Delisle, then Director of the Observatory of Paris, would not allow Messier (who was his assistant) to disclose the fact of his discovery, and he remained the only professed astronomer who saw the comet before it became lost

* "The Story of the Comets Simply Told for General Readers." By George F. Chambers, F.R.A.S. Oxford: at the Clarendon Press. 1909.

in the sun's rays at its perihelion passage. Let us hope that Hind's remark on this incident will remain true: "Such a discreditable and selfish concealment of an interesting discovery is not likely to sully again the annals of Astronomy." This strange conduct of Delisle's carried its own punishment, for when Messier's observations were afterward published some members of the French Academy treated them as forgeries; but there appears to have been no sufficient ground for this imputation, and it was eventually withdrawn. It remains to be added that the comet passed its perihelion on March 12th, 1759—just within the limits assigned by Clairaut. After that, it was seen throughout Europe during April and May, although to the best advantage only in the Southern Hemisphere. On May 5th it had a tail 47 deg. long.

Previous to the return of the comet in 1835, numerous preparations were made to receive it.

The great progress which had been made since 1759 in telescopes and methods of observation, especially under the inspiration of the two Herschels, Sir William and Sir John; and also in mathematics applied to celestial motions by men like Laplace, Lalande, La Grange, and other eminent foreigners, rendered the study of the movements of this comet, both visually when the time came to see it, and mathematically, before that time, a problem of great interest. As long before the expected return of the comet as 1817 the Academy of Sciences at Turin offered a prize, open to astronomers of all nations, for an essay on the perturbations undergone by the comet since 1759. Baron Damoiseau of Paris gained the prize, and his essay was published in 1820 in the Memoirs of the Turin Academy, vol. xxiv. The following outline of the researches of Damoiseau and others is epitomized from Hind's statement of them.

After calculating the effects of the attraction of the larger planets he fixed November 4th, 1835, at 8 P. M., Paris M.T., as the moment of the comet's perihelion passage. After Damoiseau, another Frenchman, Count de Pontecoulant, took up the matter, more or less on the same lines as Damoiseau, with the result that his date for the perihelion was rather more than a week later than Damoiseau's, or to be exact, he fixed the perihelion for November 12th, at 17h, Paris M.T. The investigations both of Damoiseau and Pontecoulant were in a sense defective because both of them had omitted to take account of certain of the planets whose influence counted for something. Accordingly a German computer, Rosenberger of Halle, started on a new and independent investigation. Damoiseau and Pontécoulant had neither of them attached sufficient importance to the actual ellipse described by the comet in 1759. As 1759 was the starting-point from which to determine the probabilities of 1835, it was important to obtain the most accurate knowledge possible of the condition of things in 1759. Rosenberger thought that he ought to go much further back than either Damoiseau or Pontécoulant had done, and that it would be impossible to make a trustworthy prediction for 1835 unless he began as far back as 1682, and computed the perturbation between 1682 and 1759, and so led up to 1835.

In performing his task Rosenberger took account not only of the influence of the great planets Jupiter, Saturn, and Uranus, but also of the smaller influence exerted by Venus, the Earth, and Mars, with some allowance also for Encke's supposed Resisting Medium as affecting his (Enke's) Comet. Omitting in the first instance any allowance for a Resisting Medium Rosenberger named November 11th, at 0h. Paris M.T., for the comet's perihelion passage. If an allowance supposed to be appropriate were made for a Resisting Medium the perihelion would fall about a week earlier or on November 3d at 19h Paris M.T. The actual effects on the comet's motion ascribed to the smaller planets were as follows: the Earth 15 2-3 days, Venus about 5 1-3 days, and Mercury and Mars together nearly 1 day. By these periods of time (namely, about 22 days) added together, Rosenberger considered that the comet's return would be hastened. "Professor Rosenberger's investigation is remarkable for its extraordinary completeness, for the pains taken to include every possible source of perturbation, without regard to the numerical labor, and for the masterly manner in which the whole of the vast work was conducted."

Rosenberger, however, had a competitor in his own country. Lehmann thought there was room for another discussion of the elements and disturbances of the orbit of Halley's comet, and though his labors were not in some respects as meritorious as Rosenberger's they have a merit of their own, inasmuch as Lehmann took the year 1607 as his starting-point. On this basis he fixed November 26th for the perihelion passage, which was a date a fortnight later than Pontécoulant's and three weeks later than Damoiseau's.*

As early as December, 1834, astronomers began to direct their telescopes to that part of the heavens where it was supposed that the comet would be first seen. Olbers had thrown out suggestions that it might be possible to find the comet between December, 1834 and April, 1835, notwithstanding that the perihelion passage would not take place till many months later. Olbers' suggestion was largely acted upon, for it applied to the constellations Auriga and Taurus which were very favorably placed for observation in Northern and Central Europe, while Sir John Herschel at the Cape employed his great reflector also in sweeping for the anxiously expected body. But all these early efforts were wasted.

It was not until the morning of August 6th that the first view of the comet was obtained, and the fortunate man was Dumouchel, director of the Collegio Romano Observatory at Rome, using a powerful telescope in a splendid climate. The comet was close to the computed place which was near ζ Tauri. It was a faint, misty object, discernible with difficulty, and moonlight and unfavorable weather during the next following days delayed the comet's discovery elsewhere. However, on August 21st W. Struve found it with the great telescope at Dorpat, and during the following week it was seen at all the principal English and Continental observatories. The Dorpat observations showed that Rosenberger's predicted place was only seven minutes of arc wrong in R. A. and 17 minutes in Declination. The effect of this error was to retard the perihelion passage till November 16th, or five days later than the epoch fixed upon by Rosenberger. During the first three weeks of September the comet's brightness gradually increased, and on the 23rd it was seen with the naked eye by Struve, and on the following day with the naked eye by Kaiser at Leyden, though it was not sufficiently bright to attract general notice till the end of the month. A tail was first seen on September 24th, and during October the comet was more or less conspicuous, but observers differed very much in their estimates of the maximum length of the tail. The average of the estimates would seem to have been from 20 deg. to 25 deg., though one observer did put it at 30 deg. The comet was lost to view about the time of perihelion passage disappearing below the S. W. horizon, and having, according to most accounts, lost its tail before the comet itself was lost to view. After the perihelion passage the comet was again observed at some of the southern observatories of Europe and at the Cape of Good Hope from December 30th to the middle of May, 1836.

Smyth's observations deserve to be quoted. Under the dates of October 10th and 11th he wrote:

"October 10th. The Comet in this evening's examination presented an extraordinary phenomenon. The brush, fan, or gleam of light, before mentioned, was clearly perceptible issuing from the nucleus, which was now about 17 seconds in diameter and shooting into the coma; the glances at times being very strong, and of a different aspect from the other parts of the luminosity. On viewing this appearance it was impossible not to recall the strange drawing of the 'luminous sector' which is given by Hevelius in his 'Annus Climactericus' as the representation of Halley's Comet in 1682 and which had been considered as a distortion.

"October 11th. ...The tail was increasing in length and brightness, and, what was most remarkable, in the opposite direction to it there proceeded from the coma across the nucleus a luminous band or lucid sector more than 60 sec. or 70 sec. in length and about 25 sec. broad, with 2 obtuse-angled rays, the nucleus being its central point. The light of this singular object was more brilliant than the other parts of the nebulosity, and considerably more so than the tail; it was therefore amazingly distinct. On applying as much magnifying power as it would bear, the nucleus appeared to be rather gibbous than perfectly round: but with the strange sector impinging it was a question of difficulty."

The observations made at the Cape of Good Hope by Maclear disclose a remarkable succession of phenomena. Though the perihelion passage took place on November 15th, 1835, Maclear did not begin to see the comet, or at any rate to record what he saw, till January 24th, 1836. He says that the alteration of form which had taken place between the beginning of November and this date, during which interval the comet had been lost in the Sun's rays, was "remarkable," and he goes on as follows:

"January 24th. To the naked eye it was as bright as a star of the 2.3 or third magnitude; there was no tail. In the 14 feet reflector, it presented an opaque, circular, planetary disc, tolerably well defined, encompassed by a delicately bright coma or halo, which was likewise circular.

"Crossing the disc in a direction not deviating much from parallelism with the equator, appeared an oblong, elliptical body, distinguished from the rest of the disc by its superior whiteness, and a semblance of greater density. The diameter of the disc measured 2 min. 11 sec.; of the coma, 8 min. 12 sec.

"On the 25th, the circularity of the preceding limb of the cometary disc was particularly broken, its dimensions were increased, the elongated portion was better marked, and its following end was brighter than the preceding.

"On the 26th, the halo had diminished, and the dimensions of the disc, or body, as it should now be called, were further increased. A spot like a nucleus could be occasionally seen in the brighter end of the oblong portion.

"On the 28th, the halo or coma had vanished. The nucleus was distinct, like a faint small star in the following end of the oblong portion. The dimensions of the body had greatly increased, while the intensity of its light had proportionately diminished. The general outline of the cometary body seemed approximating to a parabolic curve, the preceding end of which might be represented by conceiving the tail, as seen before the perihelion passage, abruptly separated from the head, leaving a serrated or ragged outline. The oblong portion with the nucleus resembled a small comet inclosed in the body of a larger one.

"On the 30th, the body was rather more elongated. A line drawn transversely through the nucleus measured 11 min. 42 sec., being 5 times the diameter on the 24th; or 29 times the area of a circle of which 2 min. 11 sec. is the diameter. But the visible area of the whole body on the 30th could not be less than 35 times that of the 24th, excluding the halo. The nucleus was nearer to the S. than to the N. side by 32 sec.

"Throughout the succeeding three months the coma went on increasing until the outline finally became so faint as to be lost in the surrounding darkness, leaving a blind, nebulous blotch with a bright center enveloping the nucleus of variable brightness, depending on moonlight or the state of the atmosphere, and variable distance."

(To be concluded.)

THE LOW COST OF REINFORCED CONCRETE CHIMNEYS.

MR. E. R. MATTHEWS in a paper on reinforced concrete chimney construction recently pointed out that among the important advantages of reinforced concrete chimneys are the lower cost, the saving of space, and the rapidity of erection. In the United States it has been found that reinforced concrete chimneys cost less than half as much as brick shafts, the saving being greater the larger the shaft. With regard to saving space, while a brick shaft, 300 feet high, would be 4 feet 10 inches thick at the base, the dimensions at the base of a concrete chimney of the same height would be: Outer wall, 9 inches; inner wall, 5 inches; intermediate space, 4 inches. From a series of tests on the effect of high temperatures on reinforced concrete, it was found that the strength of briquettes of neat cement, after exposure to a high temperature, was greater than that of similar briquettes kept in water. With concrete composed of 3 parts of sand to 1 of Portland cement, after allowing to set for 14 days in air, the strength diminished very considerably on exposure to a high temperature, but when the concrete was allowed to set for two months, it was not affected in the least when subsequently exposed to a temperature of 900 deg. F. This latter temperature may be taken as the safe limit in reinforced concrete chimneys. Heat should not be applied to concrete until the latter has set for two or, preferably, three months. It is essential also to ensure that the concrete is free from voids.

According to the Electrical Engineer, Dr. A. Koepsel has invented an apparatus for determining the composition of a gaseous mixture by estimating its electrical resistance. The apparatus is said to be specially applicable to the determination of the amount of hydrogen in water gas and of carbon dioxide in flue gases. The principle of the method is to employ a constant current to heat a wire passing through a tube filled with the gas to be analyzed. It is obvious that the temperature of the wire will vary inversely as the conducting power of the surrounding medium, and it is said that it affords a good means of ascertaining the quantitative composition of a mixture when it is known what gases are present, and when the temperatures attained in mixtures of known quantitative composition have been previously ascertained. We may remark, states our contemporary, that there is one great difficulty. The conducting power of all gases except hydrogen is very low; they differ, therefore, by small quantities. Hence reliable results must depend upon great accuracy in the measurement of the temperature of the wire. This is presumably estimated from its resistance, and it is doubtful whether it can be determined sufficiently exactly.

* The distracting effect of planetary perturbations on the movements of comets is shown by the fact that whereas the interval between the perihelion passages of Halley's comet in 1835 and 1910 is to be set down at 74 years 5½ months (the shortest on record), in 1222 and 1301 it was 79 years 2 months (the longest on record, the next longest having been 1066 and 1145).

SCIENCE NOTES.

Chlorine gas is produced by a process patented by F. W. Barteit in small quantities, either alone or mixed with air, as a bleaching mixture for laundry use. For this purpose water is allowed to drop at intervals upon a dry mixture of bleaching powder and crystals of an acid or an acid salt, 1 part of bleaching powder to 2 parts of sodium bisulphate being specially suitable. The apparatus preferably comprises a lower chamber, with detachable bottom, and an upper chamber, forming a stopper, a turn of which opens suitable passages for the admission of water from the upper to the lower chamber and for the entry of air if desired. The ingredients are introduced into the lower chamber in a removable tray.

Suppose we have a phenomenon in which chance is involved, and that two events are equally likely, such as throwing head or tail with a coin. Suppose we have a vertical board in which are stuck horizontal pegs in a regular arrangement of rows and columns. Suppose a shot be dropped over the middle of this array of pegs, and assume that if it strikes a peg it is equally likely to drop to the right or the left. The next time it strikes a peg the chances are the same. It is obviously very unlikely that a shot will continually fall on the same side, while the likeliest thing that can happen is that it shall fall in the middle. Hence if a large number of shot are let fall they will be found, if caught where they fall, to be arranged in a form limited by a curve highest in the middle, and gradually falling symmetrically toward both sides, known as the curve of errors. This curve represents graphically the result of an infinite number of causes acting, each as likely to produce a certain effect as its opposite. Take some biological subject of investigation, say the length of a certain kind of shell. Many thousands being measured, it is found that they vary from the average, but in such a way that very few differ very far from the mean. If the number having any given length is plotted vertically corresponding to the deviation from the mean laid off horizontally, we shall obtain a curve which will generally closely resemble the curve of errors. If this is the case we shall conclude that the causes of the variations in length are perfectly at random, but if we find that the curve is unsymmetrical, or for instance has two summits, we shall know that at least two sorts of causes are acting. Thus questions of heredity and variation may be mathematically studied. This method has been greatly developed by the mathematician, Karl Pearson, who has now devoted himself to the study of evolution by mathematical means.

If a bacterial culture be inoculated into a jelly with the point of a needle, it will be seen under the microscope to grow in all directions from the original center, and if pains are taken to insure the physical homogeneity of the jelly the shape of the colony will be an almost perfect circle. If the diameter of this circle be measured at regular intervals, I have no doubt that a quantitative law of growth can be deduced, and even a differential equation found, which will turn out to resemble that of certain physical phenomena, say the conduction of heat. The instruments and methods of the physiologist and the experimental psychologist are already largely physical, and their researches are carried on in laboratories. In proportion as the various circumstances are rendered more amenable to external control, so the methods of biology will more nearly approach those of physics. Whereas biology was until recently chiefly a science of observation, it has now become in a high degree experimental. The physiologist removes or alters organs, removes eggs from the natural parent and places them in a foster mother, cuts off the heads and tails of worms and observes the conditions of survival and regeneration. If the force of gravity were removed, in what direction would a plant grow? If an egg be subjected to centrifugal force, in which direction will the head of the animal appear? These are the sort of questions that the biologist is now attacking. Nor is he without mathematical statements. The great generalization of Darwin of fifty years ago has ever since concentrated attention on problems of development and heredity. Darwin's conclusions were the results of the observations of a long life. Now the experimental method enables one to hasten and accelerate conclusions. The gentle monk and acute man of science, Gregor Mendel, forty years ago in his cloister at Brünn by his careful experiments on the crossing of thousands of peas, and by comparisons of their seeds, flowers and stems, succeeded in unveiling a law which has profoundly influenced ideas on heredity, not only in plants but in animals. He finds that in the process of hybridization there are certain characteristics which are transmitted entire to the offspring, and are termed dominant, others which seem to disappear or become latent in the process, which he terms recessive. When however the hybrids are bred together both qualities reappear in the offspring, and in a definite proportion of three of the dominant to one of the recessive. In the next generation another definite proportion occurs, and so on. We here have a very definite arithmetical relation, which is susceptible of very exact study and confirmation. The method of Mendel, which we may call that of experimental evolution, is now of wide application, and there are laboratories which do nothing else but breed and cross under very exact control. Among one of the large-scale experimenters in this line may be mentioned Mr. Luther Burbank, who, though a master of method and subsidized by the Carnegie Institution, seems to be devoted rather to practical than to scientific results.

ENGINEERING NOTES.

In a recent number of Comptes Rendus, C. Hautier compares theoretically, by diagram and well-known formulæ, the adiabatic and isothermic compression and expansion of air to direct attention to the advantage of the former method, an advantage which, on the score of work utilized, is considerable. In his application the maximum pressure is limited to 15 atmospheres, the temperature of which is 363 deg. Cent., and the compressed air has very nearly that temperature in the receiver. This application is carried out on a gasoline motor car, with a view to giving to the motor couple, on transmission, the value of that of a steam engine, and without employing the usual clutches and speed-changing gear. The gasoline motor acts through an epicycloidal train differentially upon the transmission and an air compressor, and the compressor progressively brakes the exterior portion of the train. The air from the compressor is utilized immediately in a motor, and counterbalances the couple of resistance of the apparatus. As the speed increases, the effect of the air diminishes until it becomes *nil*, and the car is propelled directly by the motor.

K. Schreber in a recent number of Revue Générale des Sciences says that it is possible to obtain a large thermal return from a gas engine in which a volatile liquid is injected during the period of compression. This subject is examined (1) with reference to the use of water, (2) with reference to the thermo-dynamic calculations involved, and (3) by comparing the Banki motor with the Schreber system. Since Lenoir's day water has been injected at each stroke of the piston to lower the temperature, to lubricate the surfaces, and to increase the gaseous pressure by the addition of the steam formed, but these are in great part visionary as benefits. In result Schreber divides the compression period into three portions, in the middle one of which alone he injects the liquid so as to simply control the temperature and keep it below the igniting point of the mixture. Examination of various liquids leads him to the conclusion that alcohol is the most suitable, and that the best two-cycle engine is one worked with that liquid, and having a pump for a scavenging charge of air.

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TRADE NOTES AND FORMULÆ.

To Color Bristles and Hair Black.—Make a paste of 2 parts of slaked lime and 1 part litharge, with the aid of soap boiler's lye, with which the hair or bristles must be rubbed. After 24 hours the coloring is complete. The hair or bristles must then be washed until the paste is thoroughly removed from them.

Preserving Fluid for Bodies and Plants.—Dissolve, in 300 parts of boiling water, 100 parts of alum, 25 parts common salt, 12 parts saltpeter, 60 parts potash, and 10 parts arsenious acid. Cool and filter the solution. To 10,000 parts of this fluid, add 4,000 parts of glycerine and 1,000 parts of methyl alcohol.

Chartreuse Liqueur Essence.—25 parts orange peel oil, 15 parts neroli oil, 10 parts palm oil, 10 parts genuine cinnamon oil, 25 parts oil of lemon, 15 parts Angelica oil, 5 parts oil of wormwood, 5 parts oil of nutmeg, 1 part rose oil, 5 parts oil of coriander, 100 parts essence of violet blossoms, 50 parts pine apple ether, 1,734 parts alcohol. To be colored a golden yellow.

Burns.—First wash the burns with an antiseptic solution (preferably with a solution of boracic acid 1:30), then bind them up with antiseptic paper containing 1 per cent of boracic acid, and which has been dipped in a concentrated solution of cocaine (1-15 or ½ hydrochlorate cocaine). Over this a light covering of lint. Leave it alone for four days, or longer.

Embalming Fluid for Animals and Corpses.—Dissolve 80 parts of potash, 60 parts of common salt, 30 parts of saltpeter, and 160 parts of alum in 6,000 parts of water which has been heated to 122 deg. F. To this add a second solution of 18 parts of salicylic acid in 600 parts of methyl alcohol. To this mixture is then added 60 parts of carbolic acid and 1,800 parts of glycerine.

Bronze Alloys for Bronze Powder.—

	Copper.	Zinc.	Tin.
Bright gold	84.5	15.5	...
Red gold	90.00	9.6	0.4
Orange red	98.9	1.0	0.1
Copper red	99.9	0.1	...
Purple red	99.3	0.5	0.20
Pale yellow	82.8	17.0	0.20

Imitation Boule Furniture.—The furniture surfaces, originally made in various kinds of wood, at the places where metallic plated effects are to be obtained, are coated with a mixture consisting of graphite and gum arabic or graphite and water glass, applied in sgraffito style, and then exposed to an electroplating bath, by which means the desired metal—copper or silver—can be deposited on the graphited places. This is afterward polished with a steel burnisher and then covered or protected by a suitable varnish (copal varnish).

To Cleanse Bath Sponges.—1. Unused sponges: Turning them repeatedly, they should be beaten with a little wooden stick, to remove any sand they may contain, then they are laid in 0.5 to 1 per cent hydrochloric acid several times until no more lime is dissolved. Next they should be gently squeezed out and placed in a permanganate of potash solution (1 part to 2 parts per thousand), allow them to lie in it for ¼ to ½ an hour, press them out again and then place them in an aqueous solution of sulphurous acid (the latter dissolved from acid sulphite of soda in water) and hydrochloric or sulphuric acid added (small quantities) sulphuric acid mixed with sulphurous acid (for large quantities). After 15 minutes, squeeze the sponges out and place them in 2.5 to 5 per cent hydrochloric acid until the remains of the peroxide of manganese still adhering to them are removed. They are now of a straw yellow color; if it is desired to have them still lighter, the entire process is repeated, the sponges are then rinsed, pressed out, and dried at a moderate temperature. Brown spots may be removed by laying the cleansed sponge in a 20 per cent oxalic acid solution for a longer period. The sponge is now almost white or yellowish white, after drying in the air. If they should look somewhat brown, on account of their contact with alkalis, lay them for a time in weakly ammoniacal water, to which some peroxide of hydrogen has been added. 2. Used sponges: To be treated at certain intervals. First of all, the fatty substances are removed by repeated soaking of the sponges in 1 to 2 per cent carbonate of soda solution, at about 120 deg. F. (no concentrated or boiling solutions); finally, also, in aqueous or alcoholic ammonia. Bleach as above.

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